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Wyoming Air Quality Maintenance Area Analysis

PEDCo-Environmental Specialists, Inc, Cincinnati, Ohio

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This report contains air pollutant emissions estimates, air quality data and dispersion modeling for the base year (present) in AQMA counties in the State of Wyoming. Projections of emissions and air quality (using dispersion modeling) are made for 1980 and 1985. The adequacy of the existing Wyoming State Implementation Plan to provide for the attainment and maintenance of the National Ambient Air Quality Standards is discussed.

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WYOMING AIR QUALITY MAINTENANCE AREA ANALYSIS

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May 1976

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CONTENTS

Page

1. INTRODUCTION 1-1

2. SUMMARY 2-1

3. POWDER RIVER BASIN AQMA 3-1

Analysis Areas 3-1

Methodology 3-3

Modeling 3-4
Location of Sources 3-4
Meteorology 3-5
Background Air Quality 3-9
Location of Receptors 3-9

Emissions--Base Year and Projected 3-11

Point Sources 3-11
Area Sources 3-12

Base Year Air Quality and Model Verification 3-20

Projected Air Quality 3-23

Photochemical Oxidant Analysis 3-33

4. SWEETWATER COUNTY AQMA 4-1

Analysis Areas 4-1

Methodology 4-3

Modeling 4-3
Trona Industrial Area 4-4
Rock Springs and Green River Areas 4-7

Emissions--Base Year and Projected 4-7

Trona Industrial Area 4-7
Rock Springs and Green River Areas 4-12

Base Year Air Quality and Model Verification 4-15

Trona Industrial Area 4-17
Rock Springs and Green River Areas 4-18

Projected Air Quality 4-19

REFERENCES R-1

APPENDICES

A WYOMING POINT SOURCE SUMMARIES A-1

B DEVELOPMENT OF A PARTICULATE EMISSION FACTOR FOR SURFACE MINING IN THE POWDER RIVER BASIN OF WYOMING B-1

C WYOMING AIR QUALITY AND METEOROLOGICAL DATA C-1

D ROCK SPRINGS AND GREEN RIVER EMISSION INVENTORY AND EMISSION DENSITY D-1

E ROCK SPRINGS PROPOSED ARTERIAL STREET SYSTEM E-1

FIGURES

No.		Page
1.1	Location of Wyoming AQMA's	1-2
3.1	Powder River Basin AQMA Analysis Areas and Point Source Location	3-2
3.2	Gillette Area Source Grids	3-6
3.3	Reno Junction Area Source Grids	3-7
3.4	Douglas Area Source Grids	3-8
3.5	Example Receptor Array and Area Source Grids	3-10
3.6	Gillette Area Base Year Annual Geometric Mean Particulate Concentrations (ug/m^3)	3-24
3.7	Gillette Area Projected 1980 Annual Geometric Mean Particulate Concentrations (ug/m^3)	3-26
3.8	Gillette Area Projected 1985 Annual Geometric Mean Particulate Concentration (ug/m^3)	3-27
3.9	Reno Junction Area Projected 1980 Annual Geometric Mean Particulate Concentration (ug/m^3)	3-29
3.10	Reno Junction Area Projected 1985 Annual Geometric Mean Particulate Concentration (ug/m^3)	3-30
3.11	Douglas Area Projected 1980 and 1985 Annual Geometric Mean Particulate Concentrations (ug/m^3)	3-32
4.1	Sweetwater County AQMA Analysis Area Locations	4-2
4.2	Trona Industrial Area Point Source and Area Source Grids	4-5
4.3	Rock Springs Area Source Grids and Sampler Locations	4-8
4.4	Green River Area Source Grids and Sampler Locations	4-9
4.5	Rock Springs and Green River Emission Density	4-20

TABLES

No. Page

1.1 NAAQS for Designated Pollutants 1-3

3.1 Powder River Basin AQMA Point Source Emissions

- I. Gillette 3-13
- II. Reno Junction 3-14
- III. Douglas 3-15

3.2 Powder River Basin AQMA Area Source Categories--Particulate Emissions 3-16

3.3 Powder River Basin Projection and Allocation Reliability 3-18

3.4 Powder River Basin AQMA Area Source Particulate Emissions by Grid 3-21

3.5 Gillette Source Contribution to Areas of NAAQS Violations 3-28

3.6 Reno Junction Source Contributions 3-31

3.7 Magnitude and Extent of NAAQS Violations in Powder River Basin AQMA 3-34

3.8 Oxidant Sampling Data Selected Sites in EPA Region VIII 3-36

3.9 Ozone Data for Ohio, Pennsylvania, and Maryland 3-37

3.10 Powder River Basin Hydrocarbon Emission Density 3-40

4.1 Sweetwater County AQMA Area Source Categories Particulate and Sulfur Dioxide Emissions 4-11

4.2 Sweetwater County AQMA Area Source Particulate Emissions by Grid 4-13

4.3 Vehicle Miles Traveled (VMT) per Capita Projections 4-16

4.4 Rock Springs Particulate Emission Density and Predicted Air Quality 4-22

4.5 Green River Particulate Emission Density and Predicted Air Quality 4-22

No.		Page
4.6	Rock Springs Source Contribution to Areas of NAAQS Violations	4-23
D.1	Rock Springs Emission Inventory and Emission Density	D-1
D.2	Green River Emission Inventory and Emission Density	D-10

1. INTRODUCTION

The Wyoming Department of Environmental Quality, Air Quality Division has identified two areas that might have the potential of exceeding the National Ambient Air Quality Standards (NAAQS) because of existing air quality and/or projected growth over the next ten years (1975 to 1985). The U.S. Environmental Protection Agency has published these areas as designated Air Quality Maintenance Areas (AQMA's). They are: Powder River Basin (PRB) and Sweetwater County. The PRB includes Campbell and Converse Counties and is designated for two air pollutants: particulates and oxidants. Sweetwater County is designated for particulates and sulfur dioxide. Figure 1.1 shows the location of the two AQMA's.

Once designated as an AQMA, a detailed analysis of the impact of projected growth on air quality is required. This report presents such an analysis for the two areas.

If the AQMA analysis demonstrates that the NAAQS will not be exceeded, no plan for maintenance of standards is required and the AQMA can possibly be de-designated. However, should the analysis show a problem in attaining the NAAQS by 1975 and/or maintaining the standards from 1975 to 1985, revisions to the Wyoming Air Quality State Implementation Plan (SIP) and development of an Air Quality Maintenance Plan (AQMP) will be required.

The procedures used in the AQMA analysis are consistent with the proposed regulations on maintenance of National Ambient Air Quality Standards, 40 CFR, Part 51.[1] Table 1.1 shows the primary and secondary NAAQS for the three designated pollutants. If the ambient concentrations are projected

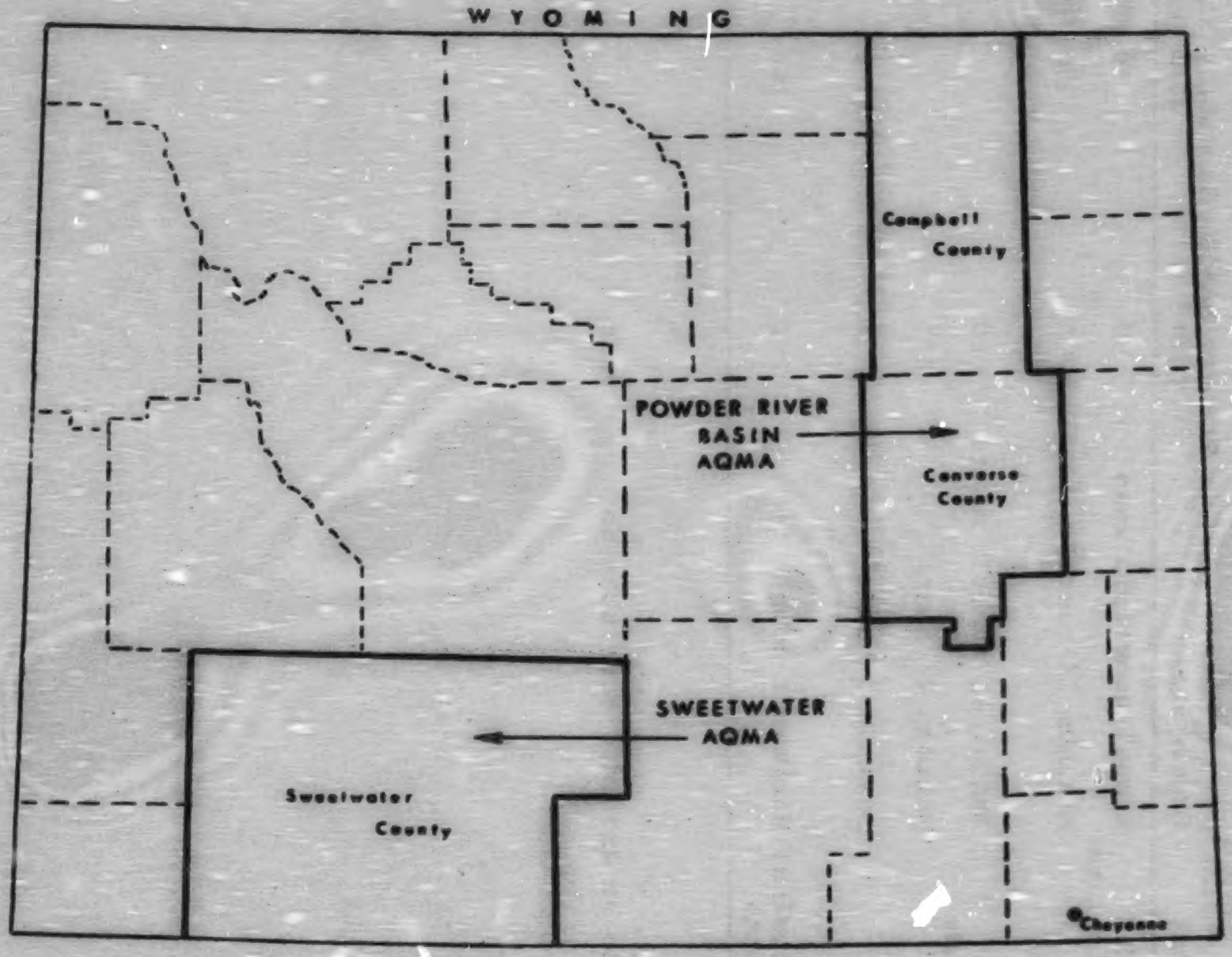

WYOMING
Campbell County
POWDER RIVER BASIN AQMA
Converse County
SWEETWATER AQMA
Sweetwater County
Cheyenne

Figure 1.1. Location of Wyoming AQMA's.

Table 1.1. NATIONAL AMBIENT AIR QUALITY STANDARDS FOR DESIGNATED POLLUTANTS

Pollutant	Frequency	Primary NAAQS, ug/m^3	Secondary NAAQS, ug/m^3
Suspended particulate	Annual geometric mean	75	60
	Maximum 24 hours[a]	260	150
Sulfur dioxide	Annual arithmetic mean	80	
	Maximum 24 hours[a]	365	
	Maximum 3 hours[a]		1300
Photochemical oxidants	Maximum 1 hour[a]	160	160

[a] Not to be exceeded more than once per year.

to exceed any of these NAAQS, a maintenance plan for that pollutant is required.

The AQMA analysis focuses on annual average concentrations. Short-term levels were not routinely analyzed due to the increased uncertainty of predicting short-term variations in future occurrences and of determining the joint probability of maximum predicted emission rates coinciding with adverse meteorological conditions. Therefore, an analysis of annual concentrations was considered adequate in cases where an attainment or maintenance problem was identified.

A base year of 1974 was used in validating the AQMA modeling. This was the most recent year for which data could be obtained. Projection years of 1975, 1980, and 1985 were used since a 10 year planning period is specified in the proposed regulations for areas in which no other federally-sponsored planning programs have been conducted.[1]

This report is divided into three major chapters. Chapter 2 summarizes the findings of the two AQMA analyses. Chapter 3 includes a detailed analysis of the Powder River Basin AQMA for particulates and photochemical oxidants. Chapter 4 includes a detailed analysis of the Sweetwater County AQMA for particulates and sulfur dioxide.

2. SUMMARY

The AQMA analysis of the Powder River Basin showed that the annual particulate NAAQS are currently being attained but that the secondary standard of 60 ug/m^3 will probably be exceeded by 1980 and remain in violation through 1985. The major cause of these predicted high particulate concentrations was shown to be dust from surface mining of coal. Two areas where violations would occur were identified--north and southeast of Gillette. No violations were shown near the Douglas or Reno Junction areas.

The accuracy of the Powder River Basin AQMA analysis was limited by several factors:

- The estimates of fugitive dust emissions from surface mining operations.
- Source-receptor relationships estimated by a Gaussian diffusion model.
- Uncertainty of projected development of coal mines.

Therefore, the confidence that the air quality projections are within ± 15 ug/m^3 is not great. On the other hand, if the projections were considerably above the NAAQS (i.e., 100 ug/m^3), an adequate margin of confidence would exist to justify implementation of maintenance measures. In addition, maintenance of NAAQS can be reasonably assured in this AQMA through Wyoming's Department of Environmental Quality ambient air monitoring program and new source permit system.

The AQMA analysis of Sweetwater County showed that the annual particulate NAAQS are currently being exceeded and will continue to be exceeded through 1985. Sweetwater County has both an attainment and a maintenance problem. The major cause of these violations was shown to be dust from uncleaned paved streets and from construction activity. Three "hot spot" areas exceeding the primary standard were identified in Rock Springs--grids number 2, 3, and 7 in the central business area. Most parts of Rock Springs and Green River were shown to violate the secondary standard. Another possible problem area was identified as the trona industrial area west of Green River, with the high projected concentrations probably due to fugitive dust emissions around the trona plants.

The accuracy of the Sweetwater County AQMA analysis was limited by the following:

- Estimates of dust emissions from unpaved roads, paved roads, and construction.
- Uncertainty of projected traffic volumes based on transportation and urban development plans.
- Assumption that particulate emission density of an area is directly proportional to air quality in that area.
- Inability to correlate air quality and emission data in the trona industrial area.

However, these AQMA analyses have applied best available modeling and emission projection techniques to quantify future air quality.

A summary of the magnitude and extent of NAAQS violations for particulates in both AQMA's is as follows:

AQMA/Subarea	Highest expected annual concentration, ug/m^3			Extent of area violating NAAQS, mi^2		
	1974	1980	1985	1974	1980	1985
Powder River Basin				(Secondary std)		
North of Gillette	bkgd[a]	68	75	--	8	35
Southeast of Gillette	bkgd	62	65	--	10	10
East of Reno Junction	bkgd	56	58	--	--	--
Sweetwater County				(Primary std)		
Rock Springs, #2	74	93	99	--	.34	.34
Rock Springs, #3	115	114	113	1.27	1.27	1.27
Rock Springs, #7	101	118	121	1.43	1.43	1.43

[a] bkgd = background

The trona industrial subarea in Sweetwater was not shown in the summary table of NAAQS violations since the analysis of this area was qualitative. This was due to the inability to correlate air quality and emission data.

The oxidant analysis for Powder River Basin indicated that the one-hour standard may already be exceeded and that it will probably continue to be exceeded in the future as a result of natural contributions alone. Although emission controls for organic compounds from man-made sources would not assure attainment or maintenance of the NAAQS, they would minimize the incremental effect of projected development in the AQMA.

In conclusion, the analyses performed herein indicate the need to de-designate the Powder River Basin AQMA for oxidants and particulates. It is recommended that a continuous monitoring program and the evaluation of the ambient air quality in the Powder River Basin be maintained to determine if an AQMP will be needed at some future date.

The AQMA analysis of Sweetwater County shows that the annual and short-term SO_2 NAAQS are currently being maintained and will continue to be maintained. Therefore, the development of an AQMP for SO_2 is not necessary. But because of the present and projected particulate violations in Sweetwater County, it is recommended that an attainment plan and an AQMP be initiated for this AQMA.

3. POWDER RIVER BASIN AQMA

ANALYSIS AREAS

The Powder River Basin encompasses an area of about 150 miles by 100 miles. Since current air pollutant dispersion models are unable to perform computations for an area this size, the Powder River Basin was divided into three smaller areas. Boundaries for these smaller areas were drawn to include major existing and projected sources of air pollutant emissions. These sources include urban areas, power plants, major transportation corridors, coal mining activity, and coal gasification plants.

The three AQMA analysis areas are Gillette, Reno Junction, and Douglas. Figure 3.1 shows the location of the three areas and existing and projected coal related activity.[2]

The Gillette area is primarily rolling terrain and can be characterized as having a potential for rapid development. This new development is associated with an increase in mining activity. Presently, two mines (Wyodak and Amax South) are active near Gillette. It is anticipated that five new mines (Carter Oil, Amax North, Kerr-McGee, Carter Oil South, and Sun Oil) and expansion of existing mines will occur by 1980.[2] This growth in mining activity will induce new population and construction in the town of Gillette and an increase in highway and railroad traffic.

The second area, Reno Junction, is located about 40 miles south of the town of Gillette and is also characterized by rolling terrain. No urban development currently exists in this area, although a small trailer park of approximately

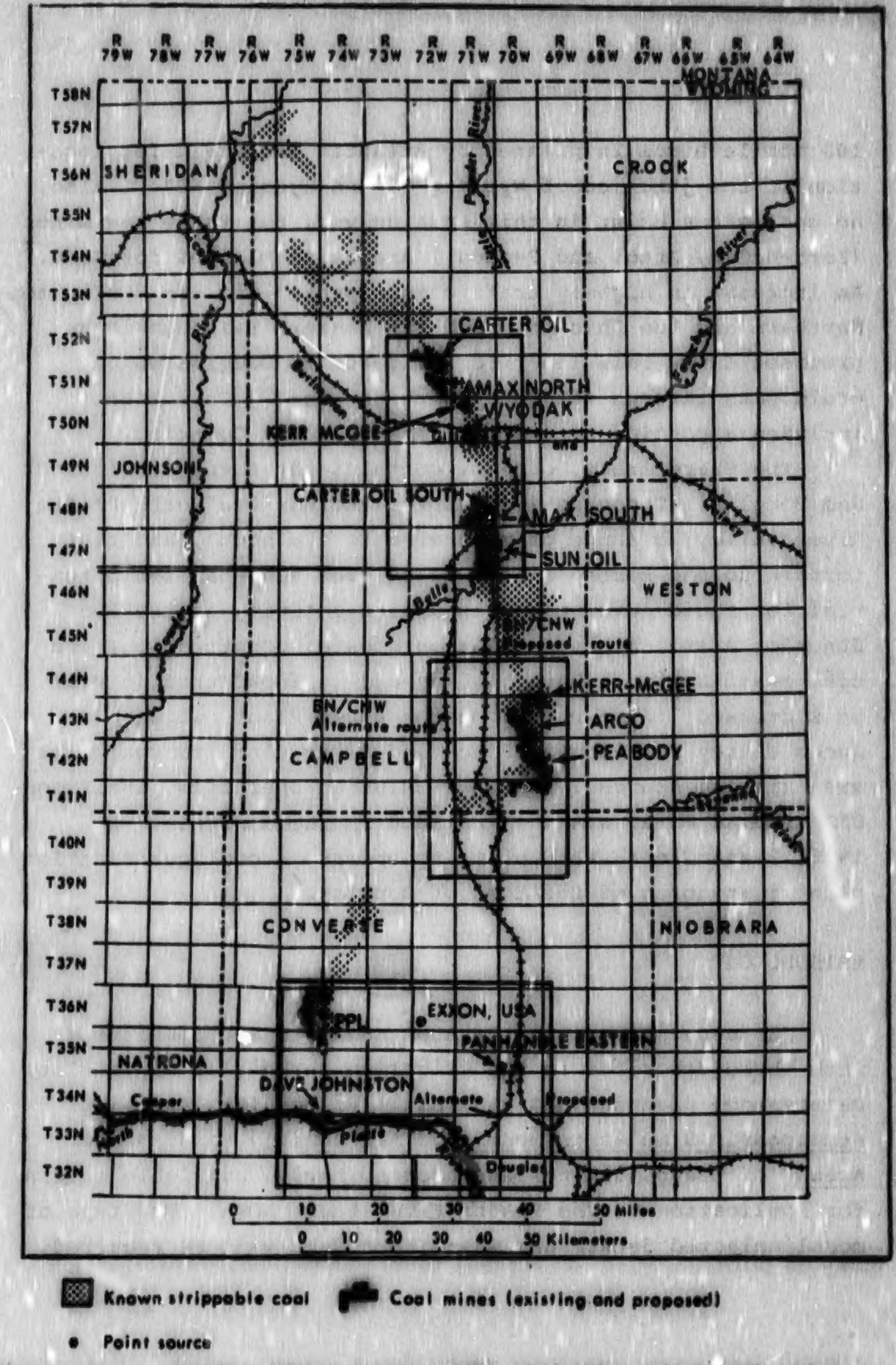

R 79W
R 78W
R 77W
R 76W
R 75W
R 74W
R 73W
R 72W
R 71W
R 70W
R 69W
R 68W
R 67W
R 66W
R 65W
R 64W
MONTANA
WYOMING
T58N
T57N
T56N
T55N
T54N
T53N
T52N
T51N
T50N
T49N
T48N
T47N
T46N
T45N
T44N
T43N
T42N
T41N
T40N
T39N
T38N
T37N
T36N
T35N
T34N
T33N
T32N
SHERIDAN
CROOK
JOHNSON
CAMPBELL
WESTON
CONVERSE
NIOBRARA
NATRONA
Powder River
River
CARTER OIL
AMAX NORTH
WYODAK
KERR MCGEE
Gillette
CARTER OIL SOUTH
AMAX SOUTH
SUN OIL
BN/CNW
Proposed route
KERR-McGEE
ARCO
PEABODY
BN/CNW
Alternate route
PPL
EXXON, USA
PANHANDLE EASTERN
DAVE JOHNSTON
Casper
North
Platte
Alternate
Proposed
Douglas
0
10
20
30
40
50 Miles
0
10
20
30
40
50 Kilometers
▨ Known strippable coal
Coal mines (existing and proposed)
● Point source

Figure 3.1. Powder River Basin AQMA analysis areas and point source location.

100 mobile homes is planned by Atlantic Richfield for location at the junction of Wyoming 59 and Wyoming 387.[3] Also, no coal mines exist in this area as yet, but three new mines (Kerr-McGee, Arco, and Peabody) are being planned for 1980.[2] An increase in highway traffic is expected and the Burlington Northern and the Chicago and North Western railroads have proposed a new rail line from Gillette to Douglas which would pass through the Reno Junction area.[2] This area includes a portion of Campbell and Converse Counties.

The third area, Douglas, contains the towns of Glenrock and Douglas. Topographic features include the North Platte River valley; a range of mountains to the south; and flat terrain to the north. The Douglas area also has the potential for rapid development as mining activity in the Reno Junction area induces population growth, construction, and coal gasification. Both highway and railroad traffic will be increased.[2] The Dave Johnston Power Plant, which produces energy for Pacific Power and Light, and its coal mine are existing sources. Another existing operation, the Exxon USA uranium mine, was not included in the analysis. By 1985, Panhandle Eastern plans to operate a coal gasification plant just north of the town of Douglas.[4]

METHODOLOGY

The methods used in the AQMA analysis are consistent with those described in the guideline series for air quality maintenance planning and analysis. Volume 12: Applying Atmospheric Simulation Models to Air Quality Maintenance Areas[5] of the guidelines was used to review available models for application to the Powder River Basin AQMA. The type of model selected determines what input data will be required.

Modeling

Two atmospheric dispersion models were considered for determining particulate concentrations in the three AQMA analysis areas: Air Quality Display Model (AQDM)[6] and Climatological Dispersion Model (CDM).[7] The CDM was excluded since it required meteorological data in day-night STAR program format. Meteorological data obtained from the National Weather Service for the Powder River Basin were summarized in STAR program format, the input format for AQDM. Therefore, AQDM, which estimates annual mean and maximum concentrations at given receptor locations for both point and area emission sources, was selected. The AQDM is applicable to flat or rolling terrain.

The following data are required for AQDM:

- Location of sources
- Emission rates
- Meteorology
- Background air quality
- Location of receptors

The following sections discuss each of these data for the three AQMA analysis areas.

Location of Sources

The locations of point sources in the Powder River Basin were previously shown.

Each AQMA analysis area was subdivided into grids. These grids were used to apportion county-wide area source emissions. Most grids were 10 km with the exception of some 5 km grids used to obtain better spatial resolution around urban areas.

The locations of these area source grids for Gillette, Reno Junction, and Douglas are shown in Figures 3.2, 3.3, and 3.4, respectively.

Meteorology

Available meteorological data recorded by the National Weather Service (NWS) and private industry were reviewed according to the following criteria: representativeness of the area to be modeled; completeness of the data; and format required by AQDM. The rationale for selecting data for each area is presented below.

For the Douglas area, the NWS Casper STAR program data (8 obs/day, 1967-71) were selected. Panhandle Eastern meteorological data at the south site (Douglas) were compared to the Casper STAR program data and showed a strong similarity in wind direction and wind speed. The Panhandle Eastern data were not in the proper format for modeling and additional summarization would have been necessary. Since there are no recorded annual mixing heights for this area, Holzworth[8] isopleths were used to determine an average afternoon annual mixing height of 2000 meters.

For the Gillette and Reno Junction area, the NWS Moorcroft STAR program data (24 obs/day, 1950-52) were selected. Since Casper and Moorcroft meteorological data are the only complete data available for these two areas, they were compared for similarity. There was only moderate correlation between these two sets of data, as Casper had much higher wind speeds and less stable atmospheric conditions than Moorcroft. Since Moorcroft is closer (20 to 30 miles) to these two areas than Casper (80 to 100 miles), it is probably more representative. There are no recorded annual mixing heights for these two areas so Holzworth[8] isopleths were used to determine an average afternoon annual mixing height of 2000 meters.

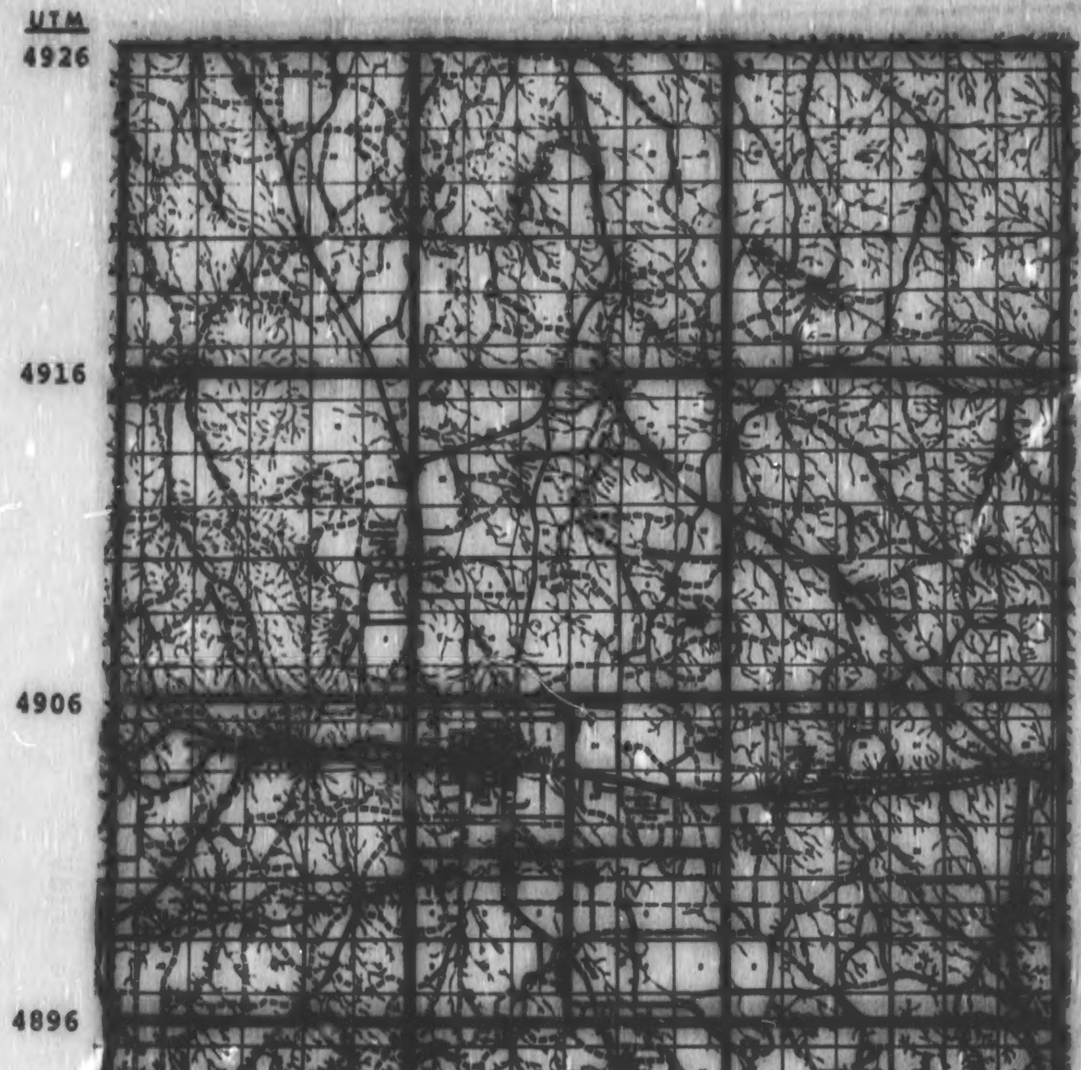

UTM
4926
4916
4906
4896
4886
4876
448
458
468
478

Figure 3.2. Gillette area source grids.

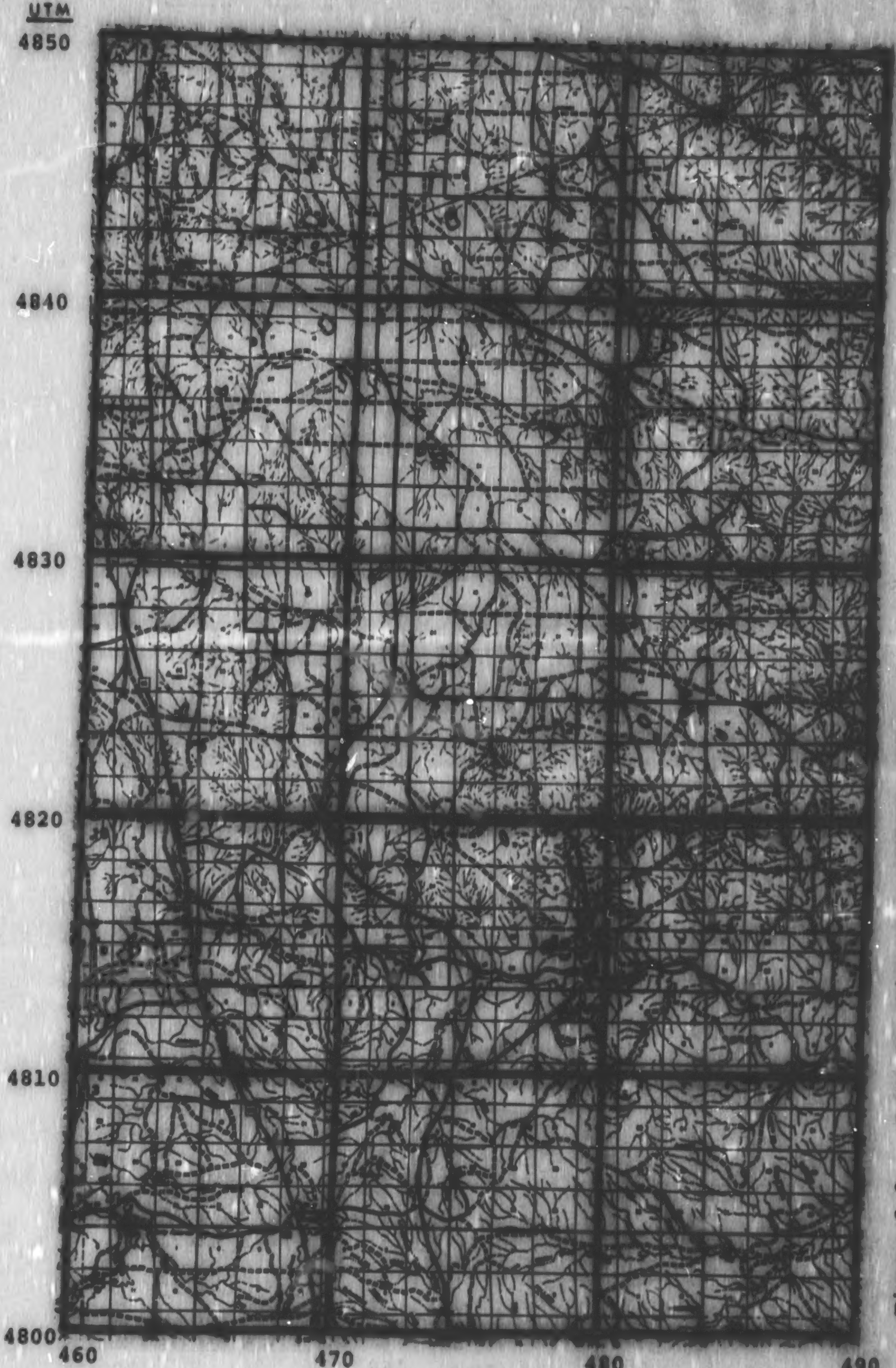

UTM
4850
4840
4830
4820
4810
4800
460
470
480
490

Figure 3.3. Reno Junction area source grids.

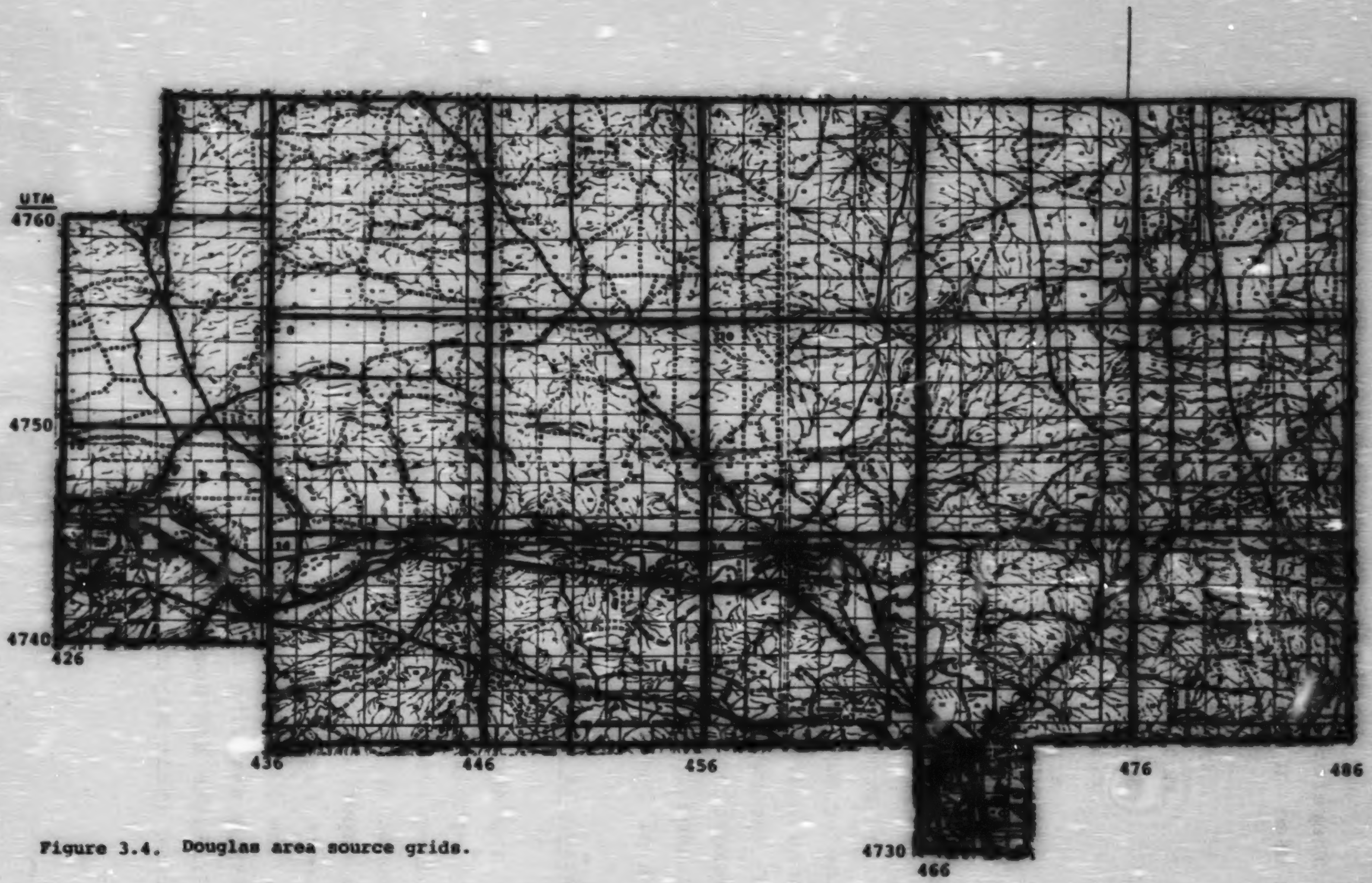

UTM
4760
4750
4740
4730
426
436
446
456
466
476
486

Figure 3.4. Douglas area source grids.

Therefore, the following meteorological assumptions were used in the AQMA analysis:

- Casper is representative of Douglas
- Moorcroft is representative of Reno Junction and Gillette
- Five year and three year NWS data are representative of base year and projected years

Background Air Quality

The Stoddard Ranch high volume sampling site operated by the Wyoming Department of Environmental Quality recorded an annual arithmetic mean particulate concentration of 27 ug/m^3 (geometric mean of 23 ug/m^3). This value was used as a background concentration for each of the three AQMA analysis areas. The site location is approximately 50 miles north of Douglas in the Reno Junction area.

Location of Receptors

The AQDM allows the user to input a rectangular array of receptors and up to 12 special receptors.[5] For the three modeling areas, an array was specified so as to place a receptor at each corner of a 5 by 5 km grid. This array was then superimposed over the area source grids. An example is shown in Figure 3.5.

The 12 special receptors for each area were located at: existing sampling sites (two in Reno Junction and one each in Gillette and Douglas); points of expected high concentration (near major point and area sources).

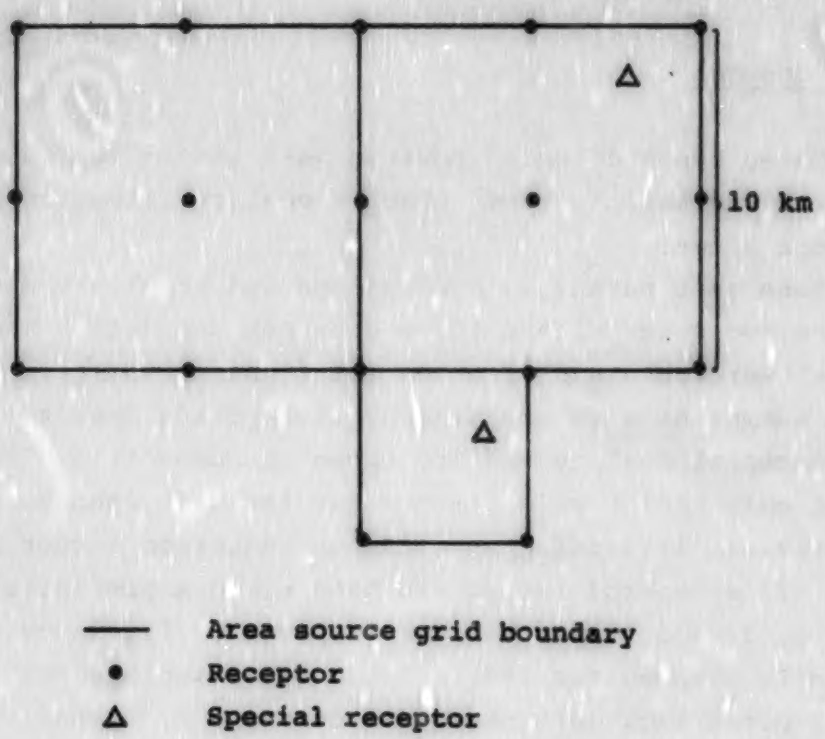

10 km
Area source grid boundary
Receptor
Special receptor

Figure 3.5. Example receptor array and area source grids.

EMISSIONS--BASE YEAR AND PROJECTED

Pollutant emissions are divided into two major categories: point source and area source. The following discusses the emissions data used as input to AQDM for the base year and projection years.

Point Sources

Three types of point sources were identified in the Powder River Basin: power plants; coal gasification plants; and coal mines.

Base year particulate emissions and stack parameters for the two power plants (Dave Johnston and Neil Simpson or Wyodak) were obtained from the point source summaries. These summaries were prepared by the Wyoming Department of Environmental Quality and are shown in Appendix A. Projected emissions were estimated for the Dave Johnston plant for 1980 and 1985 using an emission reduction factor of 0.87. This control factor was used since a precipitator on units 1, 2, and 3 operating at 98 percent efficiency is presently planned for 1980. Projected emissions for the Wyodak plant include: phase-out of units 1, 3, and 4; addition of a 330 MW unit by 1980; and addition of a 450 MW unit by 1985.[2] Emissions from unit 5 will be reduced by 78 percent by the addition of control equipment and emissions from the additional units will meet the New Source Performance Standards for particulates (0.1 $lb/10^6$ Btu) and Wyoming Air Quality Emission Standards.[2] Stack parameters for the additional units were obtained from the point source modeling data in the Northern Great Plains Resource Program.[9]

Emissions and stack parameters for the proposed Panhandle Eastern coal gasification plant were obtained from the Environmental Impact Statement (EIS) on the coal gasification project for Campbell and Converse Counties.[4] Since emission data for the proposed Carter Oil coal gasification plant were not available, it was assumed that Panhandle Eastern emissions would be representative. The Panhandle Eastern plant and the Carter Oil plant are expected to be on line in 1985.

Base year and projected emissions for coal mines were estimated from tons of coal mined. A particulate emission factor was developed for surface mining in the Powder River Basin, as explained in Appendix B. The final EIS for development of coal resources in the Eastern Powder River Basin[2] was used to obtain estimates of the number of tons of coal mined at each mine in the base year and projection years.

Table 3.1 shows particulate emissions for each point source in the three AQMA analysis areas. These data were used to model the Powder River Basin for the base year and projection years. Stack parameters for the projected point sources are shown in the point source summaries in Appendix A.

Although mining activity was considered to be a point source in this report, it was treated as a superimposed area source (area = 2 km square) in the AQDM simulation. This was done since emissions occur over an area and are not emitted from a stack.

Area Sources

Base year and projected county-wide particulate emissions for each area source category were obtained from the Wyoming AQMA Area Source Emission Inventory.[10] Table 3.2 shows the summary of these emissions. A detailed description of the procedure used to estimate area source emissions can be found in the inventory report.

Table 3.1. POWDER RIVER BASIN AQMA POINT SOURCE EMISSIONS

(ton/yr)

I. Area: Gillette

		Coal mines		Plants
Point source	Comment	Tons mined	Partic emissions	Partic emissions
Year: 1974				
Wyodak Power Plant	Units 1,3,4,5	-	-	3,384
Amax Coal, South	Existing	2,515,000	415	-
Wyodak Resources	Existing	700,000	115	-
Year: 1975				
Wyodak Power Plant	Units 1,3,4,5	-	-	3,384
Amax Coal, South	Existing	3,000,000	495	-
Wyodak Resources	Existing	700,000	115	-
Year: 1980				
Wyodak Power Plant	Unit 5+330 MW	-	-	1,783
Amax Coal, South	Expansion	10,200,000	1,680	-
Wyodak Resources	Expansion	2,500,000	415	-
Amax Coal, North	New	15,000,000	2,475	-
Carter Oil	New	8,000,000	1,320	-
Sun Oil	New	10,000,000	1,650	-
Kerr-McGee North	New	4,200,000	693	-
Year: 1985				
Wyodak Power Plant	Unit 5,330 MW and 450 MW	-	-	3,754
Amax Coal, South	Expansion	15,000,000	2,475	-
Wyodak Resources	Expansion	5,000,000	825	-
Amax Coal, North	Expansion	20,000,000	3,300	-
Carter Oil	Expansion	12,000,000	1,980	-
Sun Oil	Expansion	12,000,000	1,980	-
Kerr-McGee North	-	4,200,000	693	-
Carter Gasification	New	-	-	1,300

Table 3.1 (continued). POWDER RIVER BASIN AQMA POINT SOURCE EMISSIONS

(ton/yr)

II. Area: Reno Junction

Point source	Comment	Coal mines Tons mined	Coal mines Partic emissions	Plants Partic emissions
Year: 1974 & 1975				
None				
Year: 1980				
Kerr-McGee	New	10,000,000	1,650	-
Arco	New	10,000,000	1,650	-
Peabody	New	11,000,000	1,815	-
Year: 1985				
Kerr-McGee	Expansion	16,000,000	2,640	-
Arco	Expansion	15,000,000	2,475	-
Peabody	-	11,000,000	1,815	-

Table 3.1 (continued). POWDER RIVER BASIN AQMA POINT SOURCE EMISSIONS

(ton/yr)

III. Area: Douglas

Point source	Comment	Coal mines Tons mined	Coal mines Partic emissions	Plants Partic emissions
Year: 1974				
Dave Johnston Power Plant	Units 1,2,3,4	-	-	26,549
PP&L Coal Mine	Existing	3,000,000	495	-
Year: 1975				
Dave Johnston Power Plant	Units 1,2,3,4	-	-	26,549
PP&L Coal Mine	Existing	3,000,000	495	-
Year: 1980				
Dave Johnston Power Plant	Precipitator on units 1,2,3 (one stack)	-	-	3,500
PP&L Coal Mine	Expansion	6,000,000	990	-
Year: 1985				
Dave Johnston Power Plant	Precipitator on units 1,2,3 (one stack)	-	-	3,500
PP&L Coal Mine	Expansion	6,000,000	990	-
Panhandle Eastern Gasification	-	-	-	1,300

Table 3.2. POWDER RIVER BASIN AQMA AREA SOURCE CATEGORIES--PARTICULATE EMISSIONS

(ton/yr)

	Campbell				Converse			
Source category	1974	1975	1980	1985	1974	1975	1980	1985
Bituminous coal	98	99	104	109	8	8	8	9
Distillate oil	25	31	80	103	12	12	18	21
Residual oil	17	21	53	68	7	7	11	12
Natural gas	8	10	20	25	4	4	5	5
Other fuels	5	6	11	14	3	3	4	4
Open burning	17	17	17	17	62	62	62	62
Highway vehicles	90	104	145	148	80	82	83	70
Off-highway vehicles	18	32	41	45	17	19	31	19
Railroads	37	37	176	232	9	9	148	206
Aircraft	-	-	-	-	-	-	-	-
Industrial processes	255	255	255	255	84	84	84	84
Unpaved roads	27,836	32,669	56,628	67,944	15,039	15,490	21,060	22,113
Agriculture	826	826	846	865	1,045	1,045	1,055	1,065
Construction	1,486	2,369	2,893	3,117	857	869	925	866
Aggregate storage	5	5	5	5	8	8	8	8
Dust from paved roads	676	777	1,399	1,751	642	655	860	892
Total	31,399	37,258	62,673	74,698	17,877	18,357	24,362	25,436

Area source emissions were projected using Volume 7 of the AQMA guidelines, Projecting County Emissions, Second Edition.[11] The change in emission rate for each source category was estimated in terms of a growth factor. Growth factors were determined from historical trends, population projections, economic projections, and other parameters indicative of changes in the activity that produces the emissions. Area source emissions were allocated to grids using Volume 13: Allocating Projected Emissions to Sub-County Areas.[12] Table 3.3 shows the relative accuracy of data used in projecting emissions for each source category and in allocating emissions to the sub-county grids. The general procedure used to allocate particulate emissions for each source category is described below.

Fuel combustion emissions were apportioned by population. Open burning, aircraft, and aggregate storage emissions were negligible when distributed into each grid. Highway emissions and dust from paved roads were apportioned by vehicle miles traveled (VMT). The VMT were calculated for each grid by determining average daily traffic (ADT) on each road link from 1974 Wyoming Traffic[13] and measuring miles of road from Wyoming Highway Department county maps. Railroad emissions were apportioned by miles of track. Emissions from off-highway vehicles were distributed by construction and agricultural activity. Industrial process emissions from heater treaters were assumed to be located near oil and gas wells.[10] Emissions from compressors were negligible when distributed.

The remaining major fugitive dust categories (agriculture, construction, and unpaved roads) were apportioned by the following techniques. For the Gillette area, agricultural emissions were distributed according to agricultural land use maps.[14] Since agricultural land use maps were not available for the Douglas area, cropland was divided into

Table 3.3. POWDER RIVER BASIN PROJECTION AND ALLOCATION RELIABILITY

Source category	Projection[a]	Allocation[b]
Bituminous coal	2[*]	2[*]
Distillate oil	2	2
Residual oil	2	2
Natural gas	1	2
Other fuels	2	2
Open burning	1	2
Highway vehicles	2	2
Off-highway vehicles	2	1
Railroads	3	3
Aircraft	3	3
Industrial processes	2	3
Unpaved roads	2	2
Agriculture	2	2
Construction	2	1
Aggregate storage	1	1
Dust from paved roads	2	2

[a] Level number dependent on source of projection data and parameter used to parallel growth.

[b] Order number dependent on parameter used to apportion county-wide emissions.

[*] 1 = least reliable
2 = moderately reliable
3 = most reliable

irrigated and non-irrigated and it was assumed that emissions from irrigated cropland occur in a one mile wide area along the North Platte River. Little agricultural activity exists in the Reno Junction area.

Residential, commercial, public, and industrial construction emissions were distributed to urban grids and grids containing existing industrial development. Highway construction emissions were distributed according to highway projects in 1974. These projects were located using the Wyoming Highway Construction Bulletin.[15]

Emissions from unpaved roads were apportioned to grids using miles of road for each surface type. Miles were measured from Wyoming Highway Department county maps.

Emissions for projection years from several minor source categories (fuel combustion, highway, off-highway, industrial processes, and dust from paved roads) were not redistributed, but were obtained instead by multiplying base year emissions for each grid by the county-wide growth factor. Projected railroad emissions were distributed according to the proposed location of the new rail line, number of trains, and miles of track.[2] Agricultural emissions in each grid and construction emissions in urban grids were projected with county growth factors. Projected industrial construction emissions were distributed into grids with proposed industrial development (i.e., Wyodak Power Plant, Panhandle Eastern Coal Gasification Plant). Projected highway construction emissions were not apportioned due to the uncertainty of their location.

Finally, emissions from unpaved roads were projected with county growth factors plus an additional weighting factor of 2.0 for those grids with anticipated higher ADT. These grids with higher ADT were identified as containing or being near active coal mines. It was assumed that some unpaved roads would be paved. These roads were identified as links between proposed coal mines and existing paved roads.

Table 3.4 presents the total area source emissions for each grid for the base year and projection years. The projection year of 1975 was not used, since emissions do not vary significantly from 1974 to 1975.

BASE YEAR AIR QUALITY AND MODEL VERIFICATION

Annual particulate concentrations measured in 1974 at sampling sites in the Powder River Basin AQMA are shown in Appendix C. All sampling stations reported that the National Ambient Air Quality Standards (NAAQS), both annual and short term, were being maintained. Most stations showed concentrations to be at or near background.

The AQDM was applied separately to each of the AQMA analysis areas using base year emissions. The output resulted in particulate concentrations for 1974. The model calculated expected annual arithmetic mean concentration at each receptor. Four receptors were located at the sampling sites operating in 1974. The following is a comparison of measured versus model-predicted annual arithmetic mean concentration at the sampling sites in the Powder River Basin:

Sampling site	Measured particulates, ug/m^3	Predicted particulates, ug/m^3
Gillette	37	39
Reno Junction	33	29
Stoddard Ranch	27	28
Douglas	38	31

The measured concentrations used in the comparison were obtained from Table C-1 (Appendix C). Data recorded at Reno

Table 3.4. POWDER RIVER BASIN AQMA AREA SOURCE PARTICULATE EMISSIONS BY GRID

(ton/yr)

Grid No.	Gillette 1974	Gillette 1980	Gillette 1985	Reno Junction 1974	Reno Junction 1980	Reno Junction 1985	Douglas 1974	Douglas 1980	Douglas 1985
1	96	361	453	105	42	50	62	89	94
2	8	21	24	301	1391	1106	53	76	80
3	54	132	170	112	548	702	205	295	310
4	141	465	580	173	341	433	43	62	65
5	344	1406	1784	257	695	891	56	81	85
6	167	395	503	122	481	615	24	51	58
7	327	691	876	182	866	1107	133	192	201
8	953	2882	3353	189	927	1187	64	92	97
9	466	267	328	46	227	289	223	321	337
10	114	249	307	216	610	639	56	81	85
11	144	272	332	266	787	830	47	68	71
12	552	1586	2029	39	56	59	142	221	236
13	222	887	596	180	242	253	380	506	525
14	219	471	586	62	104	114	311	393	407
15	357	799	1011	20	20	20	365	472	489
16	223	546	700	-	-	-	329	416	430
17	219	471	586	-	-	-	134	184	191
18	390	1893	2426	-	-	-	240	351	370
19	-	-	-	-	-	-	334	526	484

Junction and Douglas in 1974 were higher than expected due to localized dust sources near the sampler. Therefore, the 1975 data for these two samplers were used in the model calibration, since these data were thought to be more representative of regional air quality.

Using the four sets of data points, a linear regression analysis was performed to determine a line of best fit. The equation of this line is as follows:

$$y = m x + b \qquad \text{(eq.1)}$$

where m = 0.64 (slope)
b = 13.5 (y - intercept)
x = calculated concentration
y = measured concentration

The correlation coefficient, r, was calculated to be 0.64. Possible reasons for only obtaining this fair correlation are:

- Due to limited sampling data, all three modeling areas had to be combined to get a single calibration factor.
- Gillette and Reno Junction areas were modeled with different meteorological data than the Douglas area.
- The predicted concentrations are less than 15 ug/m^3 above background, which was assumed to be constant throughout the PRB. Small variations in actual background in different parts of the AQMA would have a strong influence on the total measured concentrations and resulting correlation.

In view of the major source of emissions (fugitive dust) and the limited air quality data, this correlation is adequate for applying AQDM to the Powder River Basin to determine regional air quality.

The base year concentrations, calculated by AQDM for each area, were calibrated. The procedure was to multiply the predicted concentration above the background of 27 ug/m^3 by the slope of 0.64. This corrected the uncalibrated model concentrations at each receptor. Also, the arithmetic mean was converted to a geometric mean by the following equation:[16]

$$AM/GM = e^{(1/2\ \ln^2 SGD)} \qquad \text{(eq.2)}$$

where AM = arithmetic mean
GM = geometric mean
SGD = standard geometric deviation

This equation assumes that air quality data are log-normally distributed.

Figure 3.6 shows isopleths of calibrated base year concentrations for the Gillette area. The Reno Junction and Douglas areas were not presented since the AQDM results showed all concentration near background (less than 30 ug/m^3). Regional annual particulate air quality in the Powder River Basin indicates no violations of the NAAQS in 1974.

PROJECTED AIR QUALITY

The AQDM was applied separately to each of the AQMA analysis areas using projected emissions for 1980 and 1985. Other input data (meteorological, receptor location, and background) remained the same. The model calculated expected annual arithmetic mean concentration at each receptor for 1980 and 1985. The model results were calibrated and converted to geometric values using the procedure described in the preceding section.

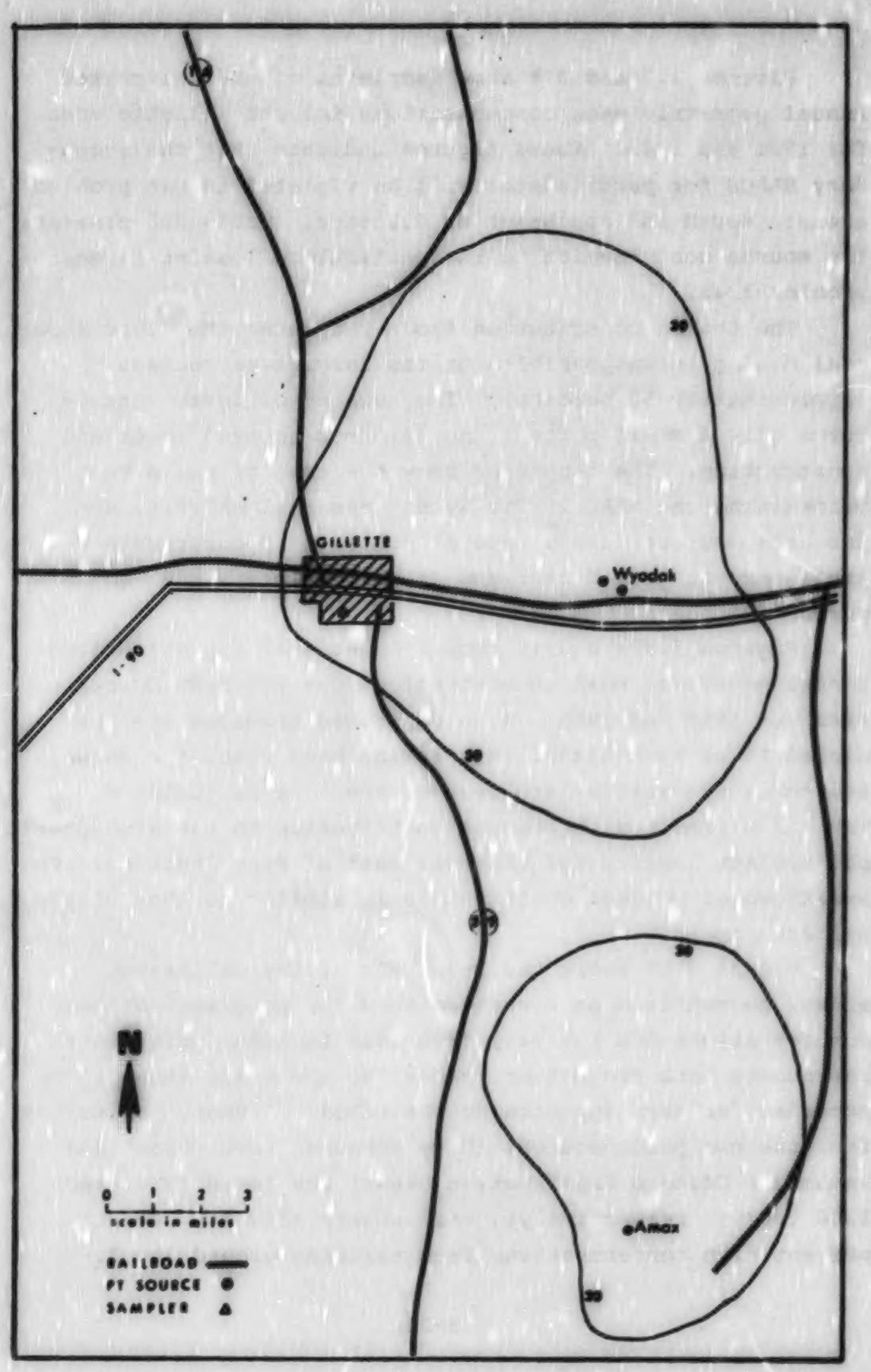

14
30
GILLETTE
Wyodak
I-90
30
59
30
N
0 1 2 3
scale in miles
Amax
30
RAILROAD
PT SOURCE
SAMPLER

Figure 3.6. Gillette area base year annual geometric mean particulate concentrations, (ug/m^3).

Figures 3.7 and 3.8 show isopleths of the calibrated annual geometric mean concentrations for the Gillette area for 1980 and 1985. These figures indicate that the secondary NAAQS for particulates will be violated in two problem areas: north and southeast of Gillette. Table 3.5 presents the source contribution to the particulate loading in each problem area.

The source contribution table indicates that dust from coal mining is responsible for the largest percentage (approximately 50 percent). The town of Gillette contributes only a small percent, mainly from unpaved roads and construction. The isopleths show the town of Gillette maintaining the NAAQS. The Wyodak power plant units and the area sources (i.e., unpaved roads) also contribute a small percentage. Background is responsible for 33 to 40 percent.

Figures 3.9 and 3.10 show isopleths of the calibrated annual geometric mean concentrations for the Reno Junction area for 1980 and 1985. Although concentrations are predicted to be much higher than in the base year, the annual standards for particulate are not shown to be violated. Table 3.6 presents the source contribution to the atmospheric particulate loading for the area east of Reno Junction. The breakdown of percent contribution is similar to that of the Gillette area.

Figure 3.11 shows the isopleths of the calibrated annual geometric mean concentrations for Douglas. Since concentrations did not vary from 1980 to 1985, this figure represents both projection years. No areas are shown to be exceeding or even approaching the NAAQS. Although emissions from the two point sources (Dave Johnston Power Plant and Panhandle Eastern Gasification Plant) are large (3500 and 1300 ton/yr, respectively), tall stacks (500 ft, 300 ft) prevent high concentrations from reaching ground level.

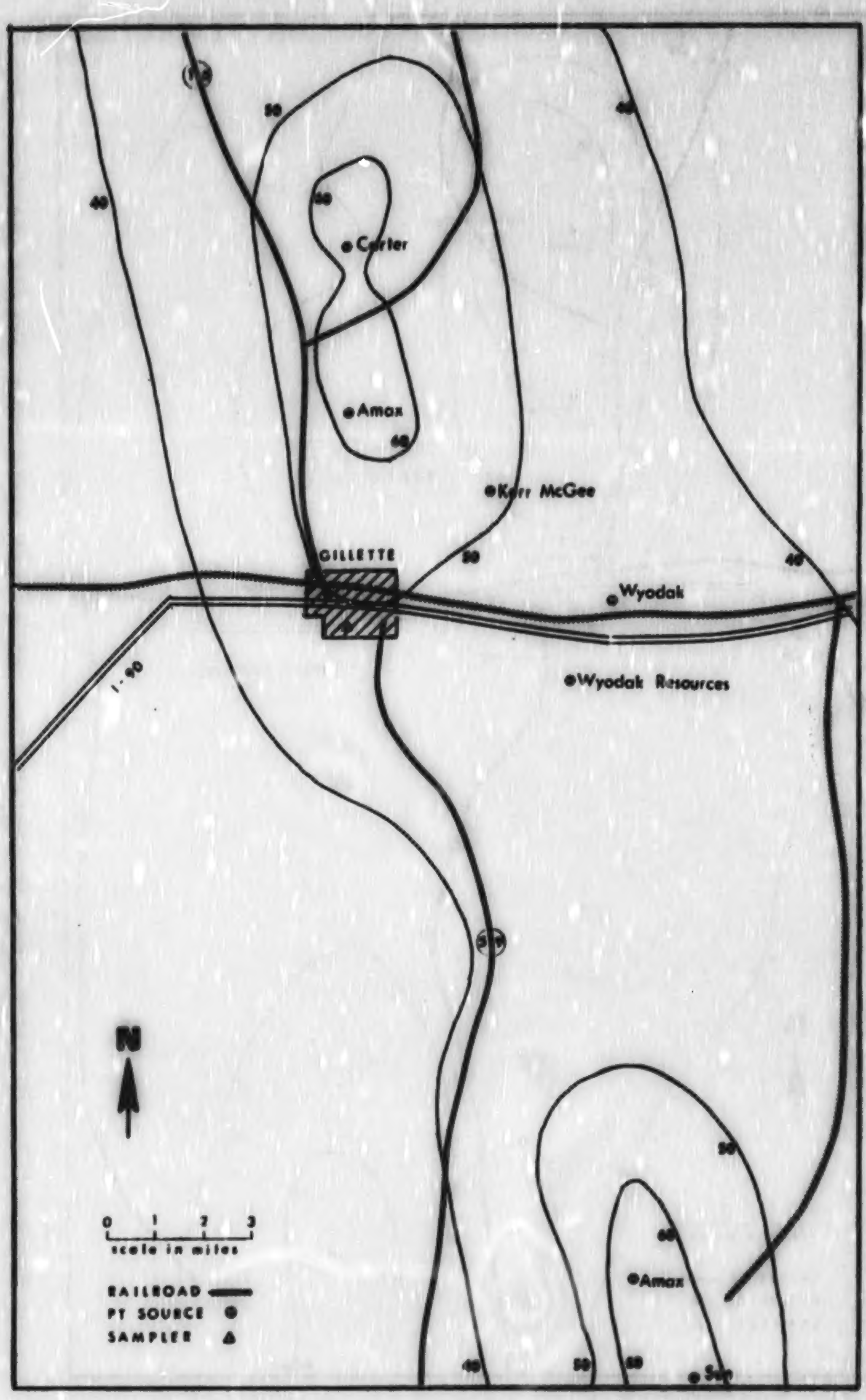
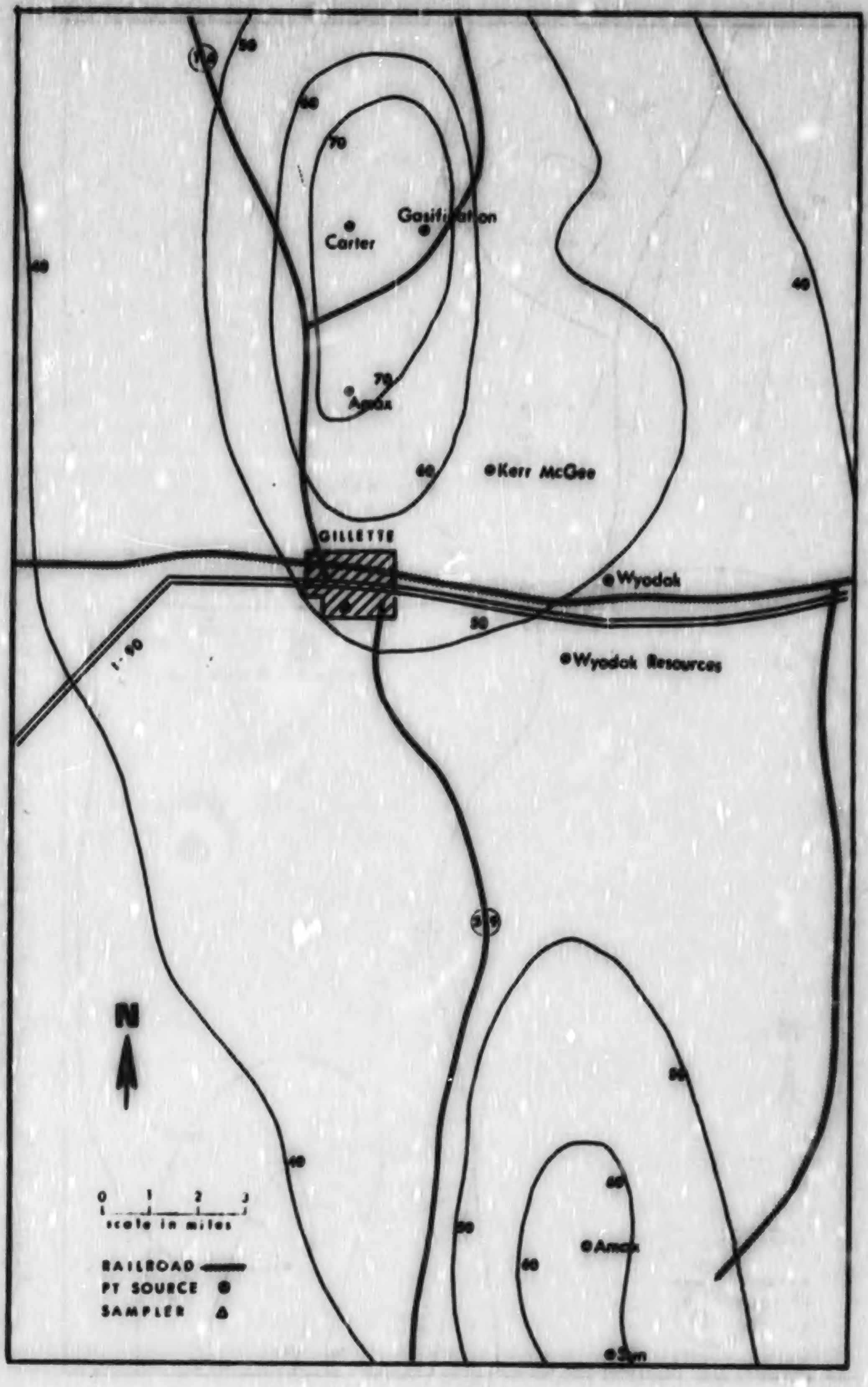

50
40
60
Carter
Amax
60
Kerr McGee
50
40
GILLETTE
Wyodak
Wyodak Resources
I-90
N
0 1 2 3
scale in miles
RAILROAD
PT SOURCE ●
SAMPLER ▲
50
60
Amax
40
50
60
Sun

Figure 3.7. Gillette area projected 1980 annual geometric mean particulate concentrations (ug/m^3).


14
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70
Gasification
Carter
40
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70
Amax
60
Kerr McGee
GILLETTE
Wyodak
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I-90
Wyodak Resources
59
N
50
40
0 1 2 3
scale in miles
60
50
Amax
60
RAILROAD
PT SOURCE
SAMPLER
Sun

Figure 3.8. Gillette area projected 1985 annual geometric mean particulate concentration (ug/m^3).

Table 3.5. GILLETTE SOURCE CONTRIBUTION TO AREAS OF NAAQS VIOLATIONS

(percent)

Source	North of Gillette 1980	North of Gillette 1985	Southeast of Gillette 1980	Southeast of Gillette 1985
Point sources				
Wyodak Unit 5	neg	neg	neg	neg
New 330 MW	neg	neg	neg	neg
New 450 MW	-	neg	neg	neg
Wyodak Resources	1	2	1	1
Amax Coal North	24	26	1	1
Carter Oil Coal	13	13	neg	neg
Amax Coal South	3	2	28	29
Sun Oil Coal	2	2	23	24
Carter Gasification	-	4	-	neg
Kerr-McGee North	6	5	neg	neg
Area sources				
Town of Gillette	7	7	2	2
Immediate grid	3	3	3	3
Surrounding grids	4	3	2	2
Background				
	37	33	40	38
Total	100	100	100	100

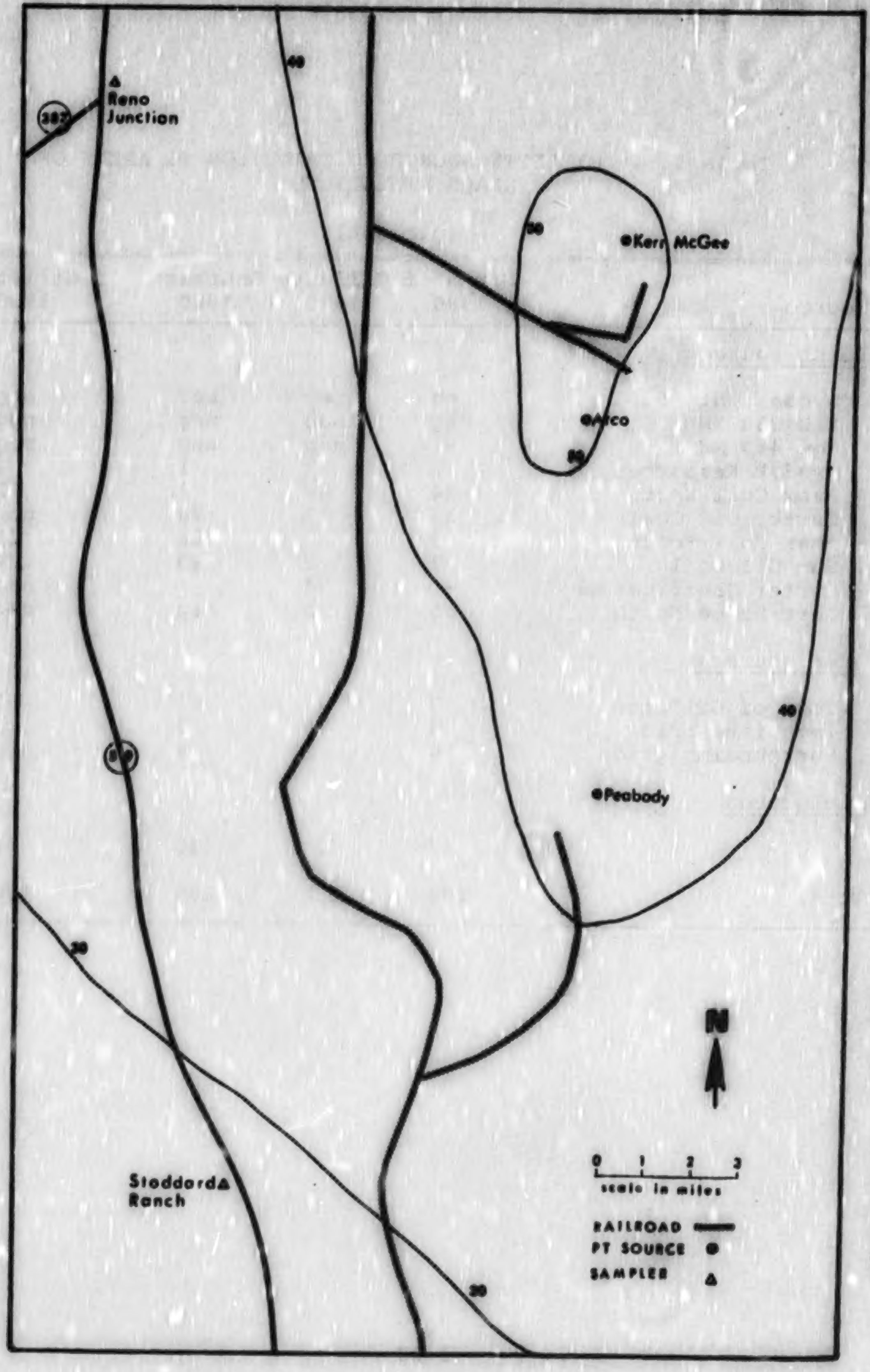

40
Reno Junction
387
50
Kerr McGee
Arco
50
40
Peabody
59
30
Stoddard Ranch
N
0 1 2 3
scale in miles
RAILROAD
PT SOURCE
SAMPLER
30

Figure 3.9. Reno Junction area projected 1980 annual geometric mean particulate concentration (ug/m^3).

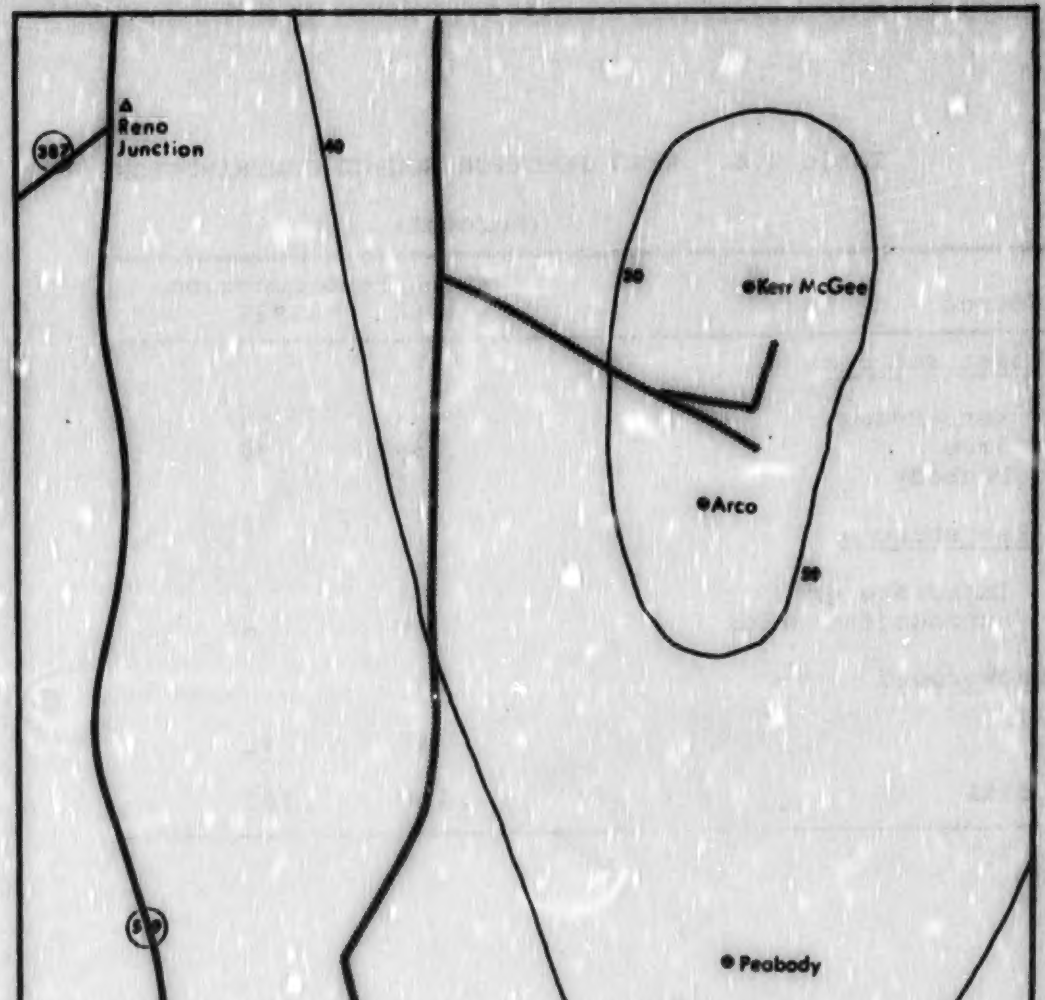

387
Reno
Junction
40
50
Kerr McGee
Arco
50
59
Peabody
50
30
Stoddard
Ranch
30
N
0 1 2 3
scale in miles
RAILROAD
PT SOURCE
SAMPLER

Figure 3.10. Reno Junction area projected 1985 annual geometric mean particulate concentration (ug/m^3).

Table 3.6. RENO JUNCTION SOURCE CONTRIBUTIONS

(percent)

Source	East of Reno Junction 1980	 1985
Point sources		
Kerr-McGee	20	23
Arco	22	22
Peabody	5	5
Area sources		
Immediate grid	2	2
Surrounding grids	5	6
Background		
	46	42
Total	100	100

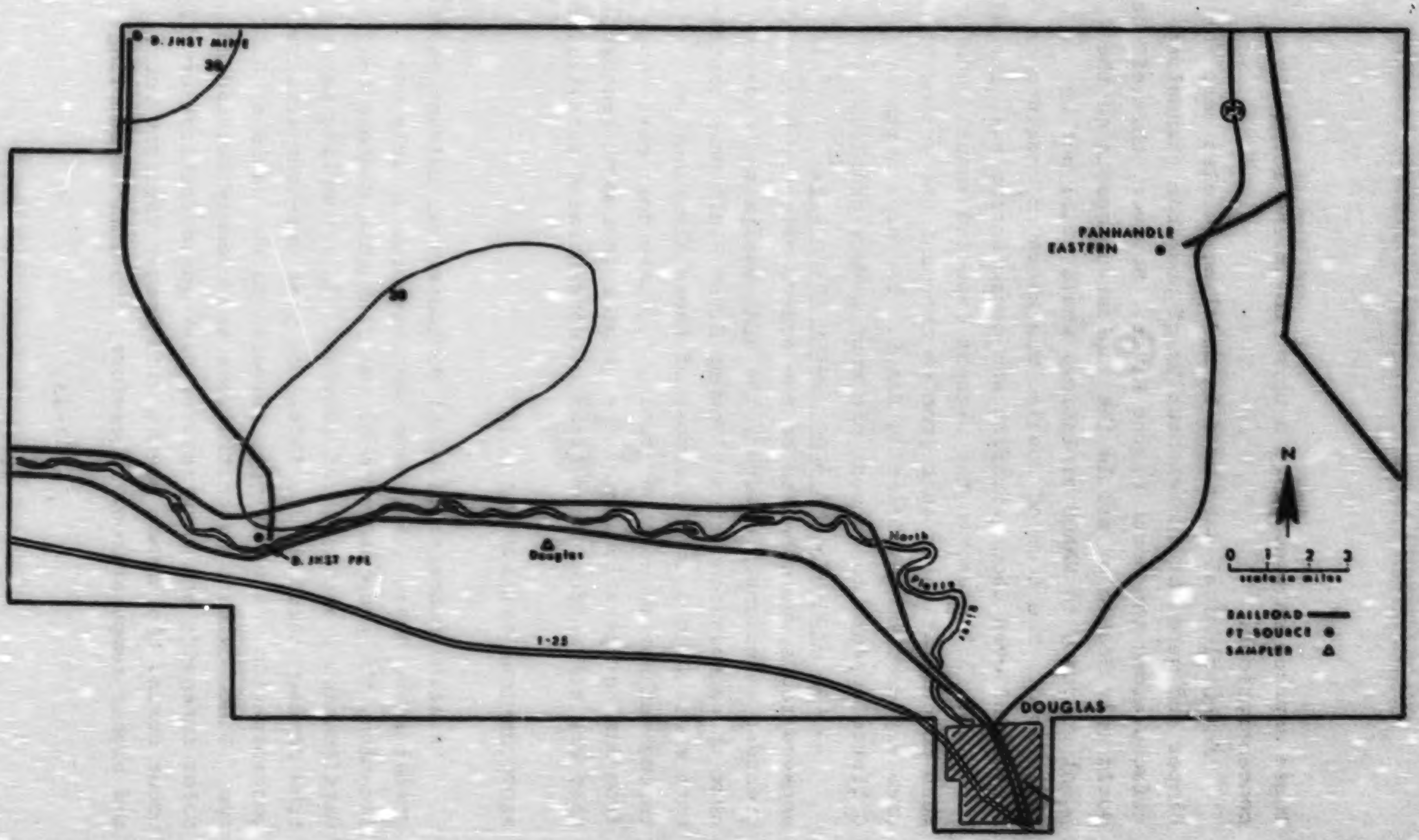

D. JHST MINE
30
30
D. JHST PPL
Douglas
I-25
North Platte River
PANHANDLE EASTERN
DOUGLAS
N
0 1 2 3
scale in miles
RAILROAD
PT SOURCE
SAMPLER

Figure 3.11. Douglas area projected 1980 and 1985 annual geometric mean particulate concentrations (ug/m3).

These sources only add 2 to 3 ug/m^3 to ground level concentrations.

Meteorological data used in modeling Douglas were for Casper and were not representative of possible channeling effects along the North Platte River. However, this effect would only double or triple the indicated impacts of the point sources, so NAAQS violations would still not be threatened. The town of Douglas was shown to remain near background even though traffic and construction will increase.

Table 3.7 presents the highest expected annual geometric mean concentration in each problem area and the extent of area expected to be violating NAAQS. The area north of Gillette appears to present the most severe problem.

In the Wyoming AQMA Area Source Inventory,[10] dust from unpaved roads was shown to be the source category having the greatest emissions. However, the AQMA analysis indicates that these emissions in the Powder River Basin only contribute about 2 to 3 ug/m^3 because of their distribution throughout the area. Conversely, fugitive dust emissions from mining operations create a greater increment because they are all emitted from areas of concentrated activity.

PHOTOCHEMICAL OXIDANT ANALYSIS

Existing concentrations of photochemical oxidant in the Powder River Basin (PRB) have been measured at only one location, the proposed site of the Panhandle Eastern Coal Gasification plant north of Douglas. In a sampling period from January through June 1974, the peak one-hour measured concentration was 0.076 ppm, compared to the NAAQS of 0.08 ppm. Since oxidant concentrations are closely related to solar intensity and temperature, peak concentrations usually occur during the summer months with longer daylight hours [illegible] higher temperatures. Therefore, the limited sampling

Table 3.7. MAGNITUDE AND EXTENT OF NAAQS VIOLATIONS IN POWDER RIVER BASIN AQMA

	Highest expected annual concentration, ug/m^3		Extent of area violating NAAQS,[a] mi^2	
Problem areas	1980	1985	1980	1985
North of Gillette	68	75	8	35
Southeast of Gillette	62	65	10	10
East of Reno Junction	56	58	--	--

[a] Secondary standard of 60 ug/m^3 geometric mean.

data available indicates that the national standard may already be exceeded in the AQMA, even though very little of the potential development of the PRB has yet occurred.

Concentrations at or exceeding the standard have also been observed at many other rural and low-population density locations in the Rocky Mountain states (EPA Region VIII), as shown by the data summarized in Table 3.8. No extended sampling for oxidants has shown levels substantially below the standard, so it might be concluded from this data that naturally occurring background concentrations throughout this part of the country approximate the standard of 0.08 ppm.

Oxidants are not emitted directly into the atmosphere but are produced by a series of chemical reactions between organic compounds (including hydrocarbons) and nitrogen oxides in the presence of sunlight. Research has shown that the rate of oxidant formation is affected by the specific organic compounds present, the ratio of organic compounds to nitrogen oxides, and the meteorological conditions such as solar intensity, temperature, and atmospheric stability.

Generally, peak concentrations are measured within a few hours of noon, although the emissions of precursor compounds (organics and nitrogen oxides) contributing to these peak concentrations may occur several hours earlier or remain from the previous day. Since the atmospheric photochemical reactions usually take several hours, the measured oxidant concentrations may occur many miles downwind from the points of emission origin. This transport phenomenon has been demonstrated quite clearly by sampling data collected at urban and rural locations in Ohio and surrounding states in 1974.[23] The rural sites, all located within 75 miles of major metropolitan areas, had levels equal to or greater than the urban locations. Data from this study are shown in Table 3.9. Identifiable impacts on oxidant air quality have

Table 3.8. OXIDANT SAMPLING DATA
SELECTED SITES IN EPA REGION VIII

Sampling site	Source of data	Peak one-hour		Date occurred	
		Highest	Next highest	Highest	Next highest
Douglas, WY	Panhandle Eastern Gasification Plant EIS	.076	.075	Jun 21, 1974	Jun 21, 1974
Beulah, ND	ANG Gasification Plant EIS	.117	.105	Jul 20, 1974	Jul 10, 1974
Colstrip, MO	Colstrip Power Plant EIS	.080	--	Jun, 1974	--
Billings, MO	Yellowstone County Air Pollution Control Agency	.156	.152	Jul 4, 1975	Jul 11, 1975
Fort Collins, CO	PEDCo	.130	.127	Oct 18, 1975	Sep 9, 1975
Oil Shale Area, CO					
Tract A	Area Oil Shale Supervisor, Dept. of Interior	.089	--	Summer, 1975	--
Tract B	Area Oil Shale Supervisor, Dept. of Interior	.080	--	Jun 26, 1975	--

Table 3.9. OZONE DATA FOR OHIO, PENNSYLVANIA, AND MARYLAND

City	Maximum one-hour concentration,[a] ppm
Urban	
Cincinnati, OH	0.18
Dayton, OH	0.13
Columbus, OH	0.15
Canton, OH	0.14
Cleveland, OH	0.14
Pittsbugh, PA	0.15
Rural	
Wilmington, OH	0.18
McConnelsville, OH	0.16
Wooster, OH	0.17
McHenry, MD	0.17
Dubois, PA	0.20

[a] Occurred during June 14 to August 31, 1974.

Source: Control of Photochemical Oxidants--Technical Basis and Implications of Recent Findings. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. Publication Number EPA-450/2-75-005. July 1975.

been shown to extend 50 to 75 miles from urban areas.[23] However, there should be no impact from urban transport in any part of the PRB because of its remoteness from major metropolitan areas.

The probable sources of oxidant in this AQMA and other rural locations in Region VIII are: (1) downward transport from the ozone-rich layers in the stratosphere, due to strong vertical mixing, and (2) photochemical generation from organics emitted by vegetation. Ozone transport from the stratosphere may produce ground level concentrations as high as 0.03 to 0.05 ppm over extended periods and can cause even higher readings for one-hour peak periods under certain meteorological conditions.[23]

Other studies have shown that organic compounds emitted by vegetation may increase oxidants by as much as 0.02 to 0.05 ppm.[24] Normally, atmospheric conditions which would produce high concentrations from downward mixing from the upper atmosphere are not conducive to high oxidant generation rates from vegetation, and vice versa. However, the additive effect from these two sources gives values that support the hypothesis that measured concentrations of 0.08 ppm and higher in rural areas in the West are almost entirely due to natural sources of oxidant.

An attempt was made to quantify the emissions from vegetation in the AQMA, primarily sagebrush, for comparison with the amount of man-made emissions as estimated in the Area Source Emission Inventory report.[10] No specific data on sagebrush emissions were found and no reliable estimate could be made due to the large variability noted in emission rates for different types of vegetation. Therefore, the ratio of locally occurring man-made emissions to naturally generated emissions cannot be accurately estimated at this time.

The Guidelines for Air Quality Maintenance Planning and Analysis[25] indicate that analyses for oxidants should be performed on a regional scale or AQMA-wide basis. Thus, hydrocarbon emission densities from man-made sources for subcounty areas (i.e., oil fields, Gillette area) were not estimated. County-wide emissions were assumed to represent a regional scale; emission densities were estimated for Campbell and Converse Counties for the base year and projection years, as shown in Table 3.10.

The resulting emission densities are significantly lower than average urban hydrocarbon emission densities (100 to 1000 ton/mi^2/yr) reported to have an impact on measured peak oxidant concentrations.[23] Even though regional emission density in the PRB is projected to increase approximately 35 percent by 1985, this density will still remain quite small as compared to an urban density.

From available air quality data and related research, it can be concluded that the NAAQS for oxidant will probably continue to be exceeded as a result of natural contributions alone. The increase in concentrations that are the result of current and projected emissions of organic compounds from man-made sources in the AQMA cannot be determined from existing data. An air quality maintenance plan would be unable to assure strict maintenance of the NAAQS for oxidants because of the impact of natural sources. However, it would still be prudent to minimize the effect of projected growth by requiring, through the use of best available control technology as mandated by Wyoming's air quality permit system, a control of new hydrocarbon emission sources.

Table 3.10. POWDER RIVER BASIN HYDROCARBON EMISSION DENSITY

	Hydrocarbon emissions, ton/yr		
	1974	1980	1985
Campbell County			
Point sources[a]			
Wyodak Power Plant			
North Simpson (20 MW)	89	21	21
New 330 MW	--	138	138
New 450 MW	--	--	188
Coal Mining Activity			
Diesel powered vehicles	26	405	562
Carter Oil			
Gasification plant	--	--	1411
Area sources[b]			
Fuel combustion	114	148	165
Highway vehicles	1450	1953	1192
Off-highway vehicles	72	113	125
Railroads	141	664	877
Aircraft	2	3	4
Industrial processes	309	309	309
Evaporative losses	6254	6394	6454
Total	8457	10148	11446
County-wide emission density, ton/mi^2/yr: (area = 5000 mi^2)	1.7	2.0	2.3
Converse County			
Point sources[a]			
Dave Johnston PP&L			
Power plant	398	398	398
Diesel powered vehicles	16	32	32
Panhandle Eastern			
Gasification plant	--	1411	1411
Area sources[b]			
Fuel combustion	20	26	28
Highway vehicles	1290	1116	552
Off-highway vehicles	55	73	60
Railroads	34	558	776
Aircraft	2	3	4
Industrial processes	85	85	85
Evaporative losses	1374	1397	1401
Total	3274	5099	4747
County-wide emission density, ton/mi^2/yr: (area = 4200 mi^2)	0.8	1.2	1.1

[a] Wyoming Point Source Summaries.

[b] Wyoming AQMA Area Source Inventory.

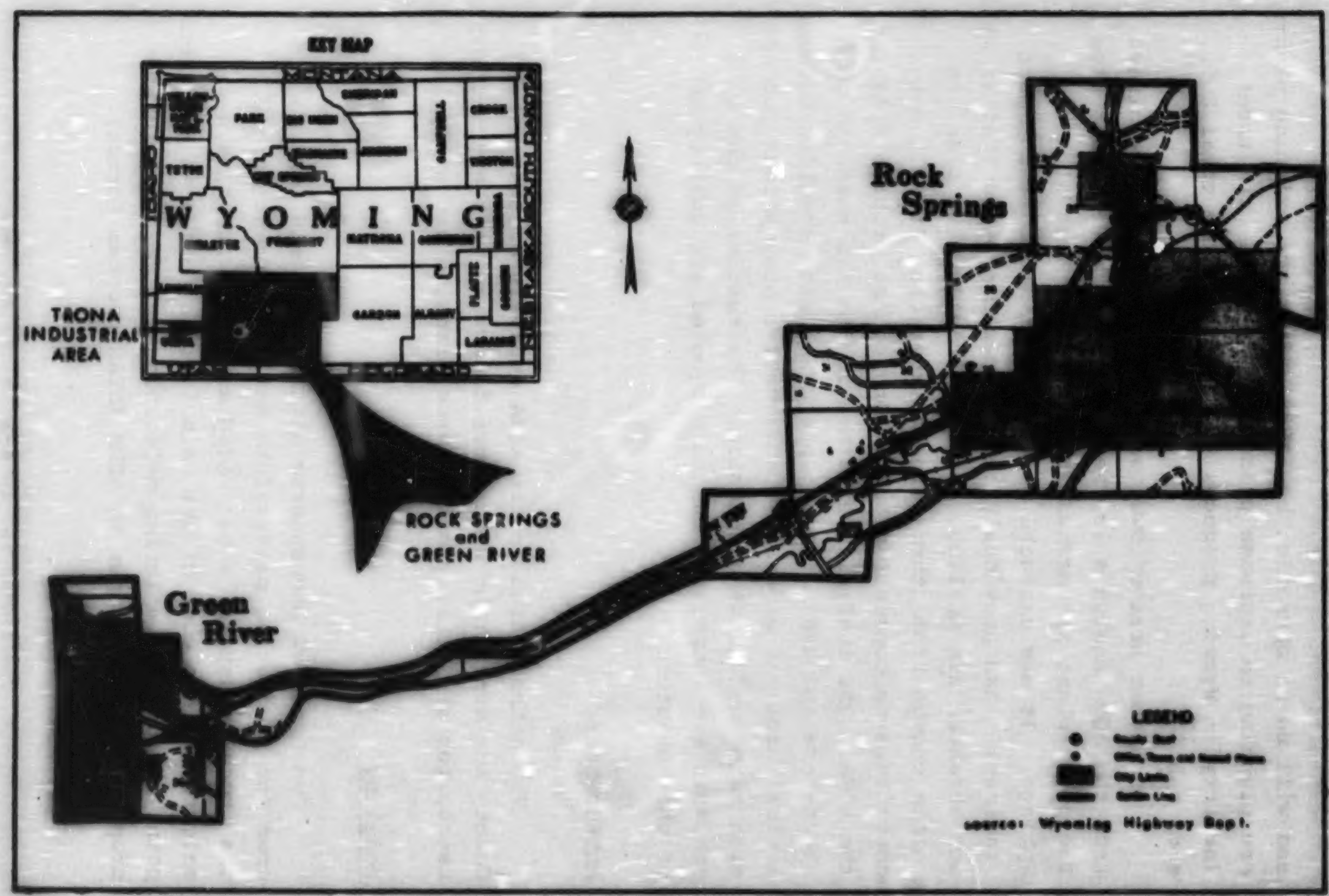
4. SWEETWATER COUNTY AQMA

ANALYSIS AREAS

Sweetwater County covers an area of about 120 miles by 90 miles. Terrain in the county includes small mountain ranges, canyons, river valleys, and flat areas. Sources of air pollutant emissions are concentrated in three areas: (1) town of Rock Springs; (2) town of Green River; and (3) trona (soda ash or sodium carbonate) industrial area. These three areas were analyzed separately in applying atmospheric diffusion models to predict future air quality. Large distances and variations in terrain were the critical factors in deciding to use separate areas.

The locations of the three AQMA analysis areas are shown in Figure 4.1. The town of Rock Springs is located along the Bitter Creek valley which runs east-west and converges to the east. The town is divided by a steep plateau (250 ft) to the north and has rolling terrain to the south. The town of Green River is located in the Green River valley which also runs east-west. This narrow valley has steep walls on both sides and a fairly uniform width. Interstate 80 is located above the town on a steep plateau (300 ft) which borders the town to the north. Both areas have been undergoing rapid urban development.

The third area, the trona industrial area, is located north of Interstate 80 and about 10 miles east of Granger. This area is characterized as having open, flat terrain. The Blacks Fork and Green Rivers run through the area. Presently, there are three industrial plants that process soda ash--FMC Corporation, Allied Chemical, and Stauffer Chemical. One new plant, Texasgulf, is under construction


KEY MAP
MONTANA
SOUTH DAKOTA
W Y O M I N G
TRONA
INDUSTRIAL
AREA
ROCK SPRINGS
and
GREEN RIVER
Rock
Springs
Green
River
LEGEND
County Seat
Cities, Towns and Named Places
City Limits
Section Line

source: Wyoming Highway Dept.

Figure 4.1. Sweetwater County AQMA analysis area locations.

and will be in operation by 1980. Also, the existing plants are planning to increase production by 1980. The trona industry in Wyoming produces 45 percent of the total U.S. soda ash.[17]

One other area of Sweetwater County that was excluded from the AQMA analysis is the Jim Bridger power plant area. The power plant is located about 30 miles east of Rock Springs. It was excluded because an environmental impact statement[18] has previously been prepared showing that it will not threaten air quality standards locally; the plant is remote enough from other large sources that it will not contribute to concentrations in any of the problem areas in the AQMA. The analysis performed in the EIS examined both short-term and annual conditions using site-specific meteorological data and generally conservative assumptions for emission rates and plume dispersion. The results of the EIS analysis are summarized in the projected air quality section of this chapter.

METHODOLOGY

The methods used in the AQMA analysis of Sweetwater County are consistent with those described in the guideline series for air quality maintenance planning and analysis.

Modeling

Two types of atmospheric diffusion models were considered for predicting particulate and SO_2 concentrations in the trona industrial area: AQDM and CDM. The AQDM was selected, since most of the emissions in this area are from point sources and existing meteorological data are in the proper format for input to AQDM (STAR program format).

Two types of atmospheric simulation models were considered for determining particulate concentrations in the Rock Springs and Green River areas: (1) ventilated valley (box) model; and (2) emission density versus air quality relationship. Gaussian diffusion models were excluded from consideration due to complex terrain. Since mixing height data were not available and the Rock Springs area had irregularly shaped valleys, the box model was excluded. (Mixing height is a critical input parameter in box modeling.) Therefore, an empirical relationship between particulate emission density and air quality was used to estimate annual average concentrations.

Trona Industrial Area

The following data were required as input to AQDM:

- Location of sources
- Emission rates
- Meteorology
- Background air quality
- Location of receptors

The locations of point sources and area source grids are shown in Figure 4.2. The large grids are 10 km square. This area includes Interstate 80, the town of Granger, and unpaved roads near the trona plants.

For meteorological data, the NWS Rock Springs Airport STAR program data (1967-71, 8 obs/day) were selected. The airport is located on a mesa above the Bitter Creek valley about 40 miles east of the trona industrial area. Data obtained from the FMC Corporation were compared to the airport data and showed a strong similarity in wind direction and wind speed. However, the FMC data were not in the

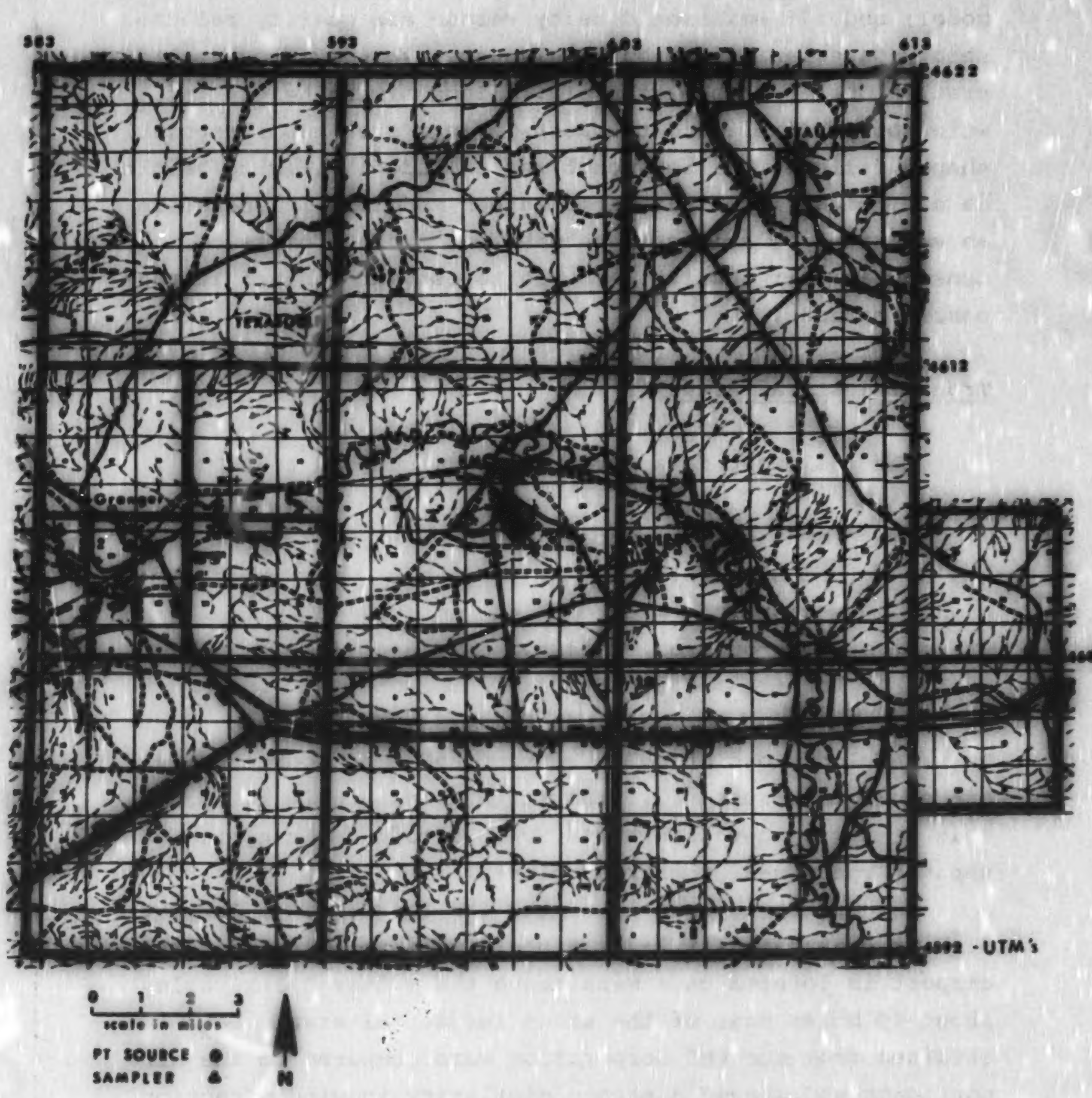

583
593
603
613
4622
4612
4602
4592 - UTM's
Texasgulf
Granger
0 1 2 3
scale in miles
PT SOURCE
SAMPLER
N

Figure 4.2. Trona Industrial Area point source and area source grids.

proper format for AQDM modeling and lacked atmospheric stability data. Data obtained from Allied Chemical were also incomplete. Since there are no recorded annual mixing heights for this area, Holzworth[8] isopleths were used to determine an average afternoon annual mixing height of 2200 meters.

The following meteorological assumptions were used in applying AQDM to this area:

- Rock Spring Airport is representative of the trona industrial area.
- Five year NWS data are representative of base year and projection years.

In 1974, the primary sources of background particulate data for Sweetwater County were the hi-vol sites operated by Texasgulf. These four sites were located west of the present trona industries. The annual geometric means from these sites are as follows:

Site 007 - 22 ug/m^3
Site 008 - 26 ug/m^3
Site 009 - 19 ug/m^3
Site 010 - 20 ug/m^3

Texasgulf's data agreed well with a previous study of five Air Quality Control Regions (AQCR's) in the western United States, in which background particulate levels in northern Nevada (similar climate to the trona industrial area) varied from 20 to 30 ug/m^3.[19] Therefore, it was determined that a background of 28 ug/m^3 (annual arithmetic mean) or 23 ug/m^3 (annual geometric mean) would be used in the AQDM simulation.

Receptors were located in the same grid configuration as described in Chapter 3 for the Powder River Basin AQMA.

Special receptors were located at the Granger sampling site and four permanent Allied Chemical sampling sites.

Rock Springs and Green River Areas

The following data were required as input to the emission density versus air quality relationship:

- Size of each grid
- Location of sampling sites
- Emissions for each grid

There are no point sources in these two AQMA analysis areas. Therefore, only area source emissions were used. The existing coal mine located near Rock Springs is an underground mine and therefore not a major point source.

Rock Springs and Green River were subdivided into grids according to topography and development density. Figures 4.3 and 4.4 show these grids and the locations of existing sampling sites.

Meteorological data were not required, since this technique assumes that ground level emission density (dust from area sources) is directly proportional to particulate air quality.

Grid sizes were measured using town planning maps and are shown in Appendix D.

EMISSIONS--BASE YEAR AND PROJECTED

Trona Industrial Area

Pollutant emissions were divided into two major categories: point sources and area sources. Two pollutants were used in the AQDM simulation: particulates and SO_2.

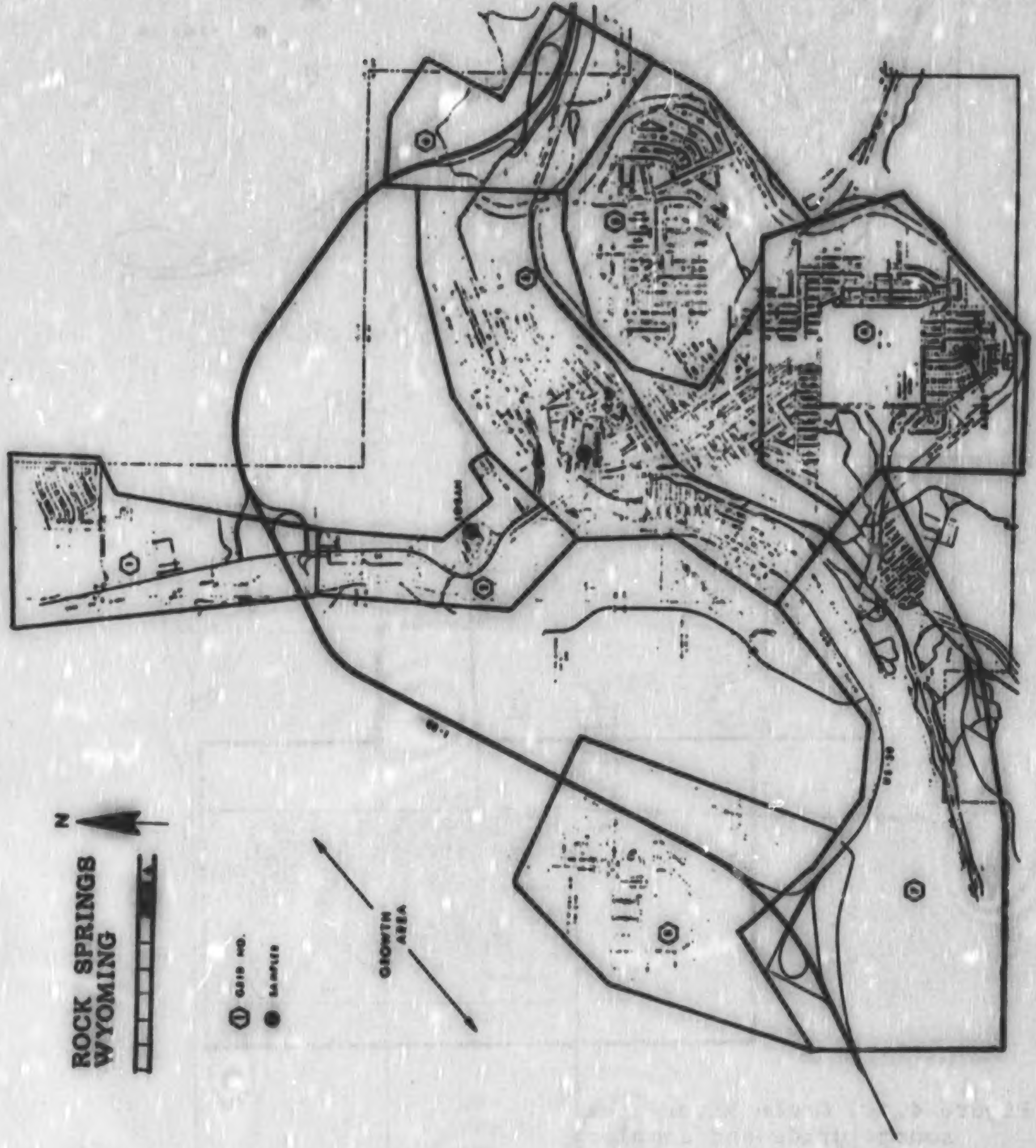

ROCK SPRINGS
WYOMING
N
Grid No.
Sampler
GROWTH AREA

Figure 4.3. Rock Springs area source grids and sampler locations.

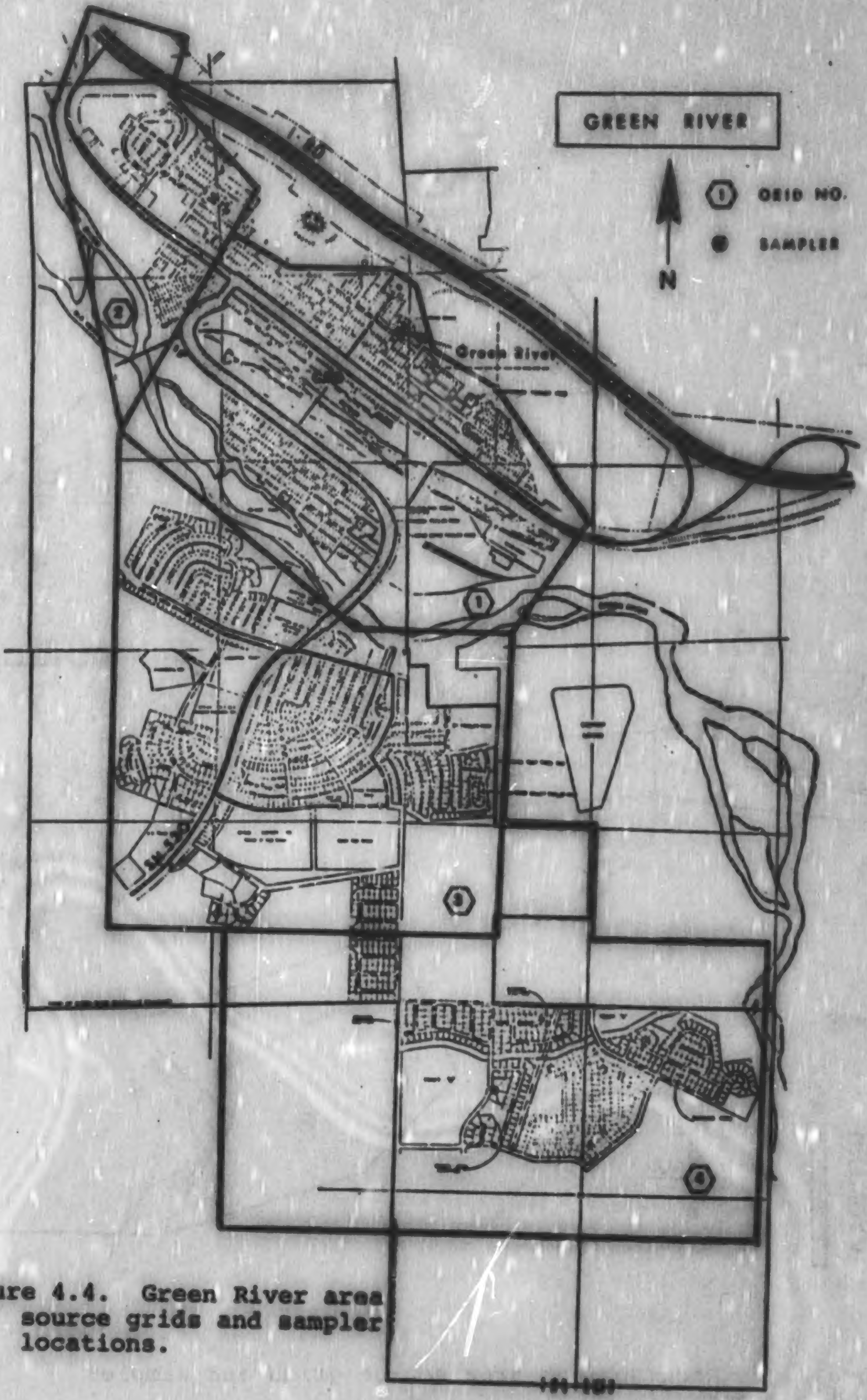

GREEN RIVER
N
GRID NO.
SAMPLER
1
2
3
4
I-80
Green River

Figure 4.4. Green River area source grids and sampler locations.

Base year particulates and SO_2 point source stack emissions and stack parameters for the three trona plants (FMC, Allied, and Stauffer) were obtained from the point source summaries in Appendix A.

Projected stack emissions for 1980 and 1985 for FMC and Allied were obtained from the Wyoming Department of Environmental Quality. Base year stack emissions for 1976 were used in projecting Texasgulf emissions to 1980 and 1985 (see Appendix A). Growth factors based on expected production rates were used to project base year stack emissions for both Texasgulf and Stauffer.

Due to the confidential nature of these projected emissions, a source-by-source presentation is not included in this report. Therefore, the following is a summary of the total stack emissions (particulate and SO_2) for all four trona plants for the base and projection years:

Total stack emissions, ton/yr

Year	Particulates	Sulfur dioxide
1974	2615	6365
1980	4721	15886
1985	6265	20537

Particulates will increase about 80 percent by 1980 and about 140 percent by 1985; SO_2 will increase about 150 percent by 1980 and 220 percent by 1985.

Base year and projected county-wide particulate and SO_2 area source emissions for each category were obtained from the Wyoming AQMA Area Source Inventory.[10] Table 4.1 shows a summary of these emissions. A detailed description of the procedure used to estimate area source emissions can be found in the inventory report.

Approximately the same procedure as described in Chapter 3 for the PRB AQMA was used to project and allocate area source emissions to grids.

Table 4.1. SWEETWATER COUNTY AQMA AREA SOURCE CATEGORIES PARTICULATE AND SULFUR DIOXIDE EMISSIONS

(ton/yr)

	Particulates				Sulfur Dioxide			
Source category	1974	1975	1980	1985	1974	1975	1980	1985
Bituminous coal	25	24	17	13	24	22	16	12
Distillate oil	24	27	36	39	70	78	105	111
Residual oil	11	12	17	18	91	102	137	146
Natural gas	42	47	63	67	3	3	4	4
Other fuels	6	7	9	9	2	2	3	3
Open burning	3	3	3	3	-	-	-	-
Highway vehicles	368	393	379	335	141	151	184	176
Off-highway vehicles	30	33	44	47	34	37	50	53
Railroads	200	200	200	200	455	455	455	455
Aircraft	4	4	5	6	2	2	3	4
Industrial processes	53	53	53	53	2	2	2	2
Unpaved roads	24,588	27,000	33,678	34,975	-	-	-	-
Agriculture	25	25	25	26	-	-	-	-
Construction	8,588	9,250	11,345	11,896	-	-	-	-
Aggregate storage	108	108	108	108	-	-	-	-
Dust from paved roads	2,325	2,488	2,999	3,139	-	-	-	-
Total	36,400	39,674	48,981	50,934	824	854	959	966

Table 4.2 presents the total area source emissions for each grid for the base year and projection years.

Rock Springs and Green River Areas

Since measured SO_2 concentrations in Rock Springs were less than 10 ug/m^3 for all 24 hour periods in 1974, the AQMA analysis for these areas was limited to particulates.

Base Year - Particulate emissions were calculated for each grid in Rock Springs and Green River for the following area source categories:

- Dust from unpaved roads
- Dust from paved roads
- Dust from unpaved shoulders
- Construction dust
- Fuel combustion
- Highway vehicles, exhaust
- Railroads

The 1974 calculated emissions, emission density, emission factors, apportioning factor, and other parameters are shown in Appendix D (Table D-1 for Rock Springs and Table D-2 for Green River).

Base year traffic data for Rock Springs and Green River were obtained from the Wyoming State Highway Department.[20,21] Green River population data were also obtained from the Wyoming State Highway Department. Construction data (location, size of area) were obtained from the Rock Springs and Green River planning departments.

Table 4.2. SWEETWATER COUNTY AQMA AREA SOURCE PARTICULATE EMISSIONS BY GRID

(ton/yr)

Grid No.	Trona Industrial Area					
	1974		1980		1985	
	PART	SO_2	PART	SO_2	PART	SO_2
1	2701	10	4262	15	3538	16
2	138	0	207	0	221	0
3	712	9	973	10	1026	10
4	22	0	31	0	34	0
5	1	3	1	3	1	3
6	237	5	353	6	375	6
7	0	0	0	0	0	0
8	658	8	892	6	942	9
9	546	8	724	9	761	9
10	87	4	112	8	112	5
11	204	4	155	8	158	5
12	303	7	299	9	315	8
13	6	0	7	0	7	0
14	109	5	91	6	94	5

Traffic data included maps of traffic volumes for major arterials and interstates. Local traffic was added by assuming that it was 20 percent of the total traffic assigned to streets in a grid. Vehicle miles traveled (VMT) were determined by multiplying traffic volumes by miles of road. The VMT data for each grid were used to estimate reintrained dust emissions from paved roads. Uncleaned streets were identified by a field trip to each town.

Emissions from unpaved roads for the base year were calculated for four types of roads. County roads and city streets have traffic with higher average speeds; local streets and alleys have lower average speeds. The VMT was determined by measuring miles of roads and streets (using town maps provided by the planning departments) and assuming average daily traffic volumes (high-100 ADT; medium-50 ADT; low-20 ADT).

The population distribution used to apportion Sweetwater County fuel combustion emissions is as follows:[21]

Rock Springs - 59 percent
Green River - 23 percent
Remainder of county - 18 percent

Percent population for each individual grid is shown in Appendix D. Vehicle exhaust emissions were apportioned by VMT. Railroad emissions were apportioned by miles of track.

Projections - The base year particulate emissions were projected to 1980 and 1985 for Rock Springs and Green River using growth factors for each source category. The growth factors, resultant emissions, and emission densities are shown in Appendix D.

Projected traffic volumes for 1980 and 1985 for major arterials and interstates were provided by the Wyoming State

Highway Department[22] for Rock Springs. These traffic volumes were converted to growth factors for each grid. Other source category emissions not related to VMT were projected with county population growth factors (1.50 for 1974 to 1980 and 1.60 for 1974 to 1985).

Projected traffic volumes for Green River were not available. Therefore, total VMT per capita for Rock Springs was compared to total VMT per capita for Green River. This ratio for Rock Springs was shown to be fairly constant through the projection years. It was assumed that Green River would have a VMT per capita of 7.0 in 1980 and 1985. This yielded a VMT growth factor of 1.54 for 1980 and 1985. Table 4.3 summarizes this analysis. The same growth factor (1.54) was used for each grid, since traffic should increase uniformly throughout this town.

One additional grid in the Rock Springs area was used to estimate projected emissions. A circular area (one mile in diameter) located in a new development section was used as a grid. This area is a floating zone, since exact development location is not known at this time. Unpaved road emissions were not calculated, since it is uncertain as to how many miles of new unpaved road will be built. Presently, no unpaved roads exist in this area.

The proposed arterial street system for Rock Springs is shown in Appendix E.

BASE YEAR AIR QUALITY AND MODEL VERIFICATION

Annual particulate and SO_2 concentrations measured in 1974 at sampling sites in the Sweetwater AQMA are shown in Appendix C. One site at Rock Springs (Fearn) and one site at Allied Chemical (Site 1) showed violations of the annual NAAQS for particulates (115 ug/m^3 and 124 ug/m^3 geometric means, respectively). One other site in Rock Springs (Logan)

Table 4.3. VEHICLE MILES TRAVELED (VMT) PER CAPITA PROJECTIONS

Parameter	Rock Springs					Green River				
	1974	GF[a]	1980	GF	1985	1974	GF	1980	GF	1985
Total VMT/day	147,737	1.44	213,018	1.57	232,720	56,758	1.54	87,500	1.54	87,500
Population	22,000	1.50	33,000	1.60	34,000	7,500	1.67	12,500	1.67	12,500
VMT/capita	6.7		6.5		6.8	7.6		7.0[b]		7.0[b]

[a] GF = growth factor

[b] assumed

approached the annual primary standard and exceeded the secondary standard. Data at other industrial sites were insufficient to calculate annual averages. All SO_2 data showed negligible concentrations, except at FMC, which had data for only one quarter in 1974.

Trona Industrial Area

The AQDM was applied to this area using base year emissions. The output resulted in predicted annual arithmetic mean concentrations for 1974-75 at each receptor. Five receptors were placed at selected sampling sites operating in 1974-75. Measured data were for the period from April 1974 to March 1975. The following is a comparison of measured versus model-predicted annual arithmetic mean particulate concentrations at the selected sampling sites in the trona industrial area:

Sampling site	Measured particulates, ug/m³	Predicted particulates, ug/m³
Granger	66	32
Allied-1	120	39
Allied-2	93	38
Allied-3	87	33
Allied-4	61	35

No comparison was made for SO_2 concentrations, since sampling data were so limited. However, the model-predicted annual arithmetic mean concentrations were all less than 5 ug/m^3.

The comparison of particulate concentrations showed that the model significantly underpredicted the measured concentrations. Two possible reasons for this underprediction are: (1) fugitive dust sources from industrial processes were assumed to be negligible; (2) Allied sampling sites were not representative of air quality in the vicinity of the plant.

An attempt was made to quantify the fugitive dust sources (i.e., tailings ponds, mining sites, shipping areas, haul roads, and stockpiles). However, test data on emission factors and associated industrial process data were unavailable. Additional research is needed in this area. Also, a very large amount of additional particulate emissions would be necessary to show an increase of 50 to 70 ug/m^3 over the presently predicted concentrations.

The Allied sites were located, installed, and operated by Allied Chemical Company and could possibly be measuring localized dust sources. Since measured concentrations within a small area differ by a factor of 2.0, the data do not appear to be representative for regional-scale analyses.

Because of the above reasons, AQDM for the trona industrial area was not verified or calibrated for the base year.

Rock Springs and Green River Areas

Emission densities for 1974 were estimated for three grids in Rock Springs and one grid in Green River. These four grids each contain a high volume particulate sampler. It was assumed that a sampler is representative of air quality in its grid.

Sampling data (annual geometric mean) for 1974 were compared to corresponding grid emission densities.

Grid No./Sampler		Measured particulates, ug/m^3	Emission density, ton/mi^2/yr
1	Green River	65	266
2	Rock Springs-Logan	74	442
3	Rock Springs-Fearn	115	730
4	Rock Springs-Alder	39	110

These data points are shown in Figure 4.5. A linear regression analysis was performed to determine a line of best fit. The equation of this line is as follows:

$$y = m x + b \qquad \text{(eq.3)}$$

where m = 0.117 (slope)
b = 27.8 (y - intercept)
x = emission density
y = particulate air quality (geometric mean)

This resulted in a background concentration of 28 ug/m^3 (zero emission density). The correlation coefficient, r, was calculated to be 0.985. This correlation between estimated emission density and sampling data is unusally high and reveals a strong relationship.

Since this relationship yielded reasonable results, the equation of the line was used to determine air quality in other grids for the base year from estimated emission densities.

PROJECTED AIR QUALITY

Particulate air quality for the trona industrial area was not projected because of problems encountered with model verification. However, if it is assumed that the Allied Chemical Company sampling sites are representative of regional air quality, then the annual NAAQS would probably continue to be exceeded given that particulate emissions are projected to increase approximately 140 percent by 1985. Since stack emissions and area source emissions accounted for only 8 to 10 ug/m^3 above background (approximately 12 percent of the highest measured concentration) in the uncalibrated AQDM model run, then fugitive dust sources associated

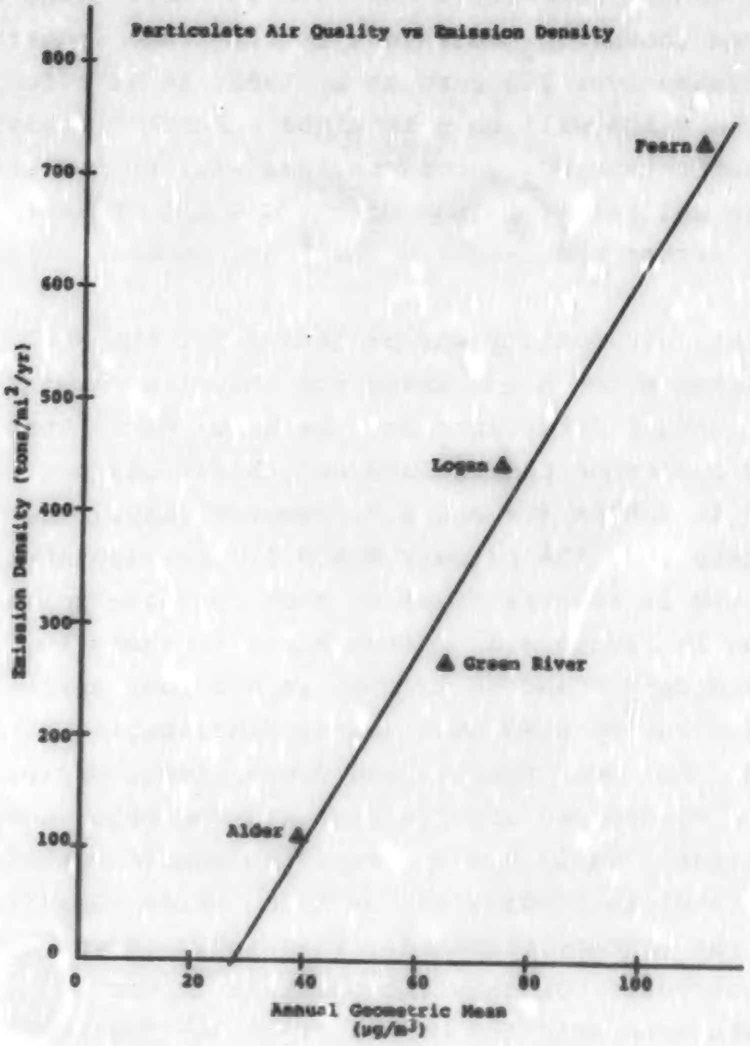


Figure 4.5. Rock Springs and Green River emission density versus particulate sampling data.

with the trona mines probably are the primary contributors to concentrations above the standard in the trona industrial area. Additional research is necessary to quantify the impact of these fugitive dust sources on measured concentrations.

Sulfur dioxide air quality was also not projected since the base year annual concentrations were so small (less than 5 ug/m^3). Even though SO_2 emissions in the trona industrial area will increase over 200 percent by 1985, it is safe to assume that the NAAQS will be maintained. Further analysis for maximum short-term SO_2 concentrations will be performed, although it is unlikely (because of the distance between sources) that either the 3-hour or 24-hour standard will be threatened.

Particulate air quality was projected for the Rock Springs and Green River areas using the emission density-air quality relationship determined for the base year. Both base year and projected particulate concentrations are shown for each grid in Tables 4.4 and 4.5, respectively. These results indicate that the primary NAAQS for particulates will be violated in several areas of Rock Springs--grids 2, 3, and 7 shown in Figure 4.3. Green River is shown to exceed the secondary standard in 1985 in all four grids.

Appendix D can be used as a source contribution table for each grid. For Rock Springs and Green River, uncleaned roads, unpaved roads, and construction are the major contributing sources. Table 4.6 presents the source contribution to particulate loading in the three grids identified as exceeding the primary standard. This table shows uncleaned roads and construction causing the greatest impact.

The growth area grid for Rock Springs has predicted concentrations of 44 and 52 ug/m^3 in the projection years and, therefore, would possibly violate the NAAQS if new unpaved roads are allowed in this area.

Table 4.4. ROCK SPRINGS PARTICULATE EMISSION DENSITY AND PREDICTED AIR QUALITY

	Emission density, ton/mi^2/yr			Suspended particulates, ug/m^3		
Grid No.	1974	1980	1985	1974	1980	1985
1	243	342	373	56[a]	68	71
2	442	558	608	80	93	99
3	730	736	726	113	114	113
4	110	160	171	41	47	49
5	107	205	220	40	52	54
6	418	362	383	77	70	73
7	629	770	797	101	118	121
8	106	235	290	40	55	62
Growth area	-	137	211	-	44	52

[a] Expected annual geometric mean.

Table 4.5. GREEN RIVER PARTICULATE EMISSION DENSITY AND PREDICTED AIR QUALITY

	Emission density, ton/mi^2/yr			Suspended particulates, ug/m^3		
Grid No.	1974	1980	1985	1974	1980	1985
1	266	376	376	59[a]	72	72
2	242	343	343	56	68	68
3	229	347	362	55	68	70
4	115	316	316	41	65	65

[a] Expected annual geometric mean.

Table 4.6. ROCK SPRINGS SOURCE CONTRIBUTION TO AREAS OF NAAQS VIOLATIONS

(percent)

Source	Grid 2			Grid 3			Grid 7		
	1974	1980	1985	1974	1980	1985	1974	1980	1985
Unpaved roads									
County roads	4	4	4	4	4	4	13	13	15
City streets	--	--	--	12	12	12	--	--	--
Local streets	15	16	16	3	3	3	--	--	--
Alleys	--	--	--	--	--	--	--	-	--
Paved roads									
Winter sanding	7	7	8	7	7	7	2	5	5
Cleaned roads	--	--	--	--	--	--	--	1	--
Uncleaned roads	33	35	36	33	33	33	9	16	16
Unpaved shoulders	4	4	4	1	1	1	1	1	1
Construction	--	--	--	10	10	10	46	39	39
Fuel combustion	1	2	2	3	3	3	--	--	--
Highway vehicles	1	2	2	2	2	2	1	1	1
Railroads	--	--	--	--	--	--	--	--	--
Background	35	30	28	25	25	25	28	24	23
Total	100	100	100	100	100	100	100	100	100

Finally, previous analyses[18,26] of the Jim Bridger power plant showed the following projected impact on ground level air quality from all four units (scheduled to be in operation by 1980):

Pollutant	Annual mean concentration, ug/m^3	Max 24-hr, ug/m^3	Max 3-hr, ug/m^3
Particulate	< 1	6	n.d.
Sulfur dioxide	18	138	529

n.d. = not determined

These concentrations would be added to the background concentration. It is apparent that this source would not by itself result in violation of the NAAQS in the surrounding area, which at present contains no other major emission sources.

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APPENDIX A

WYOMING POINT SOURCE SUMMARIES

I.D. NUMBER ST CO AQ PLT	PT	YR	PLANT/POINT NAME	UTM COORD,KM HORIZ	UTM COORD,KM VERT	STACK DATA HT. (FT)	STACK DATA DIA (FT)	STACK DATA TEMP (F)	STACK DATA FLOW (ACFM)	STACK DATA PLUME HT	ESTIMATED EMISSIONS, TPY PART	ESTIMATED EMISSIONS, TPY SO2	ESTIMATED EMISSIONS, TPY NOX	ESTIMATED EMISSIONS, TPY HC	ESTIMATED EMISSIONS, TPY CO	ALLOWABLE EMISS,TPY PART	ALLOWABLE EMISS,TPY SO2
0000			COUNTY CODES - WYOMING	.	.		.										
~~0000~~			~~CAMPBELL COUNTY~~	.	.		.										
0100			CONVERSE COUNTY	.	.		.										
0700			SWEETWATER COUNTY	.	.		.										
~~5200802430000~~	~~00~~			.	.		.										
5200802430000	01		CAMPBELL CO. PT. SOURCES	.	.		.										
5200802430000	02			.	.		.										
~~5200802430001~~	~~00~~		~~WYODAK RESOURCES~~	.	.		.										
5200802430001	01	74	WYODAK RESOURCES/	469.8	4903.9		.				~~385~~ 115						
5200802430001	02	80	WYODAK RESOURCES/	468.8	4901.2		.				~~1979~~ [illegible]						
~~5200802430001~~	~~03~~	~~85~~	~~WYODAK RESOURCES/~~	~~468.2~~	~~4902.2~~		.				~~[illegible]~~ [illegible]						
5200802430002	00		N. SIMPSON	.	.		.										
5200802430002	01	74	N. SIMPSON/BLACK HILLS #1	470.2	4903.6	57	5.4	600	28000		1612	213	273	5	15	61	
~~5200802430002~~	~~02~~	~~74~~	~~N. SIMPSON/BLACK HILLS #3~~	~~470.2~~	~~4903.6~~	~~175~~	~~5.6~~	~~560~~	~~31000~~		~~119~~	~~134~~	~~57~~	~~20~~	~~95~~	~~56~~	
5200802430002	03	74	N. SIMPSON/BLACK HILLS #4	470.2	4903.6	72	6.0	580	47000		142	158	68	34	113	56	
5200802430002	04	74	N. SIMPSON/BLACK HILLS #5	470.2	4903.6	110	8.0	500	121000		1511	998	1278	21	71	309	
~~5200802430003~~	~~00~~		~~AMAX COAL SOUTH~~	.	.		.										
5200802430003	01	74	AMAX COAL SOUTH	470.5	4880.5		.				~~1000~~ 415						
5200802430003	02	80	AMAX COAL SOUTH	470.5	4880.5		.				~~6600~~ [illegible]						
~~5200802430003~~	~~03~~	~~85~~	~~AMAX COAL SOUTH~~	~~468.9~~	~~4880.5~~		.				~~8800~~ [illegible]						
5200802430004	00		KERR MCGEE	.	.		.										
5200802430004	01	80	KERR MCGEE COAL MINE	481.0	4839.5		.				~~6600~~ 1150						
~~5200802430004~~	~~02~~	~~85~~	~~KERR MCGEE COAL MINE~~	~~481.0~~	~~4840.6~~		.				~~8800~~ 2880						
5200802430005	00		ARCO	.	.		.										
5200802430005	01	80	ARCO COAL MINE	476.2	4835.7		.				~~9900~~ [illegible]						
~~5200802430005~~	~~02~~	~~85~~	~~ARCO COAL MINE~~	~~470.2~~	~~4834.6~~		.				~~[illegible]~~ [illegible]						
5200802430006	00		PEABODY	.	.		.										
5200802430006	01	80	PEABODY COAL MINE	480.2	4825.8		.				~~4000~~ 1815						

I.D. NUMBER				UTM COORD.KM		STACK DATA					ESTIMATED EMISSIONS, TPY					ALLOWABLE EMISS.TPY	
ST CO AQ PLT	PT	YR	PLANT/POINT NAME	HORIZ	VERT	HT. (FT)	DIA (FT)	TEMP (F)	FLOW (ACFM)	PLUME HT	PART	SO2	NOX	HC	CO	PART	SO2
5200002430007	00		BLACK HILLS PP&L	.	.		.										
~~5200002430007~~	~~01~~	~~80~~	~~BLACK HILLS/NEW 330 MW~~	~~470.2~~	~~4903.6~~	~~121~~	~~3.0~~	~~400~~			~~1200~~						
5200002430007	02	85	BLACK HILLS/NEW 450 MW	470.2	4903.6	120E	3.6E	400E			1600						
5200002430008	00		AMAX COAL NORTH	.	.		.										
~~5200002430008~~	~~01~~	~~80~~	~~AMAX COAL NORTH~~	~~461.2~~	~~4910.4~~		~~.~~				~~6000~~	~~2475~~					
5200002430008	02	85	AMAX COAL NORTH	459.5	4910.4		.				20000	3300					
5200002430009	00		CARTER OIL	.	.		.										
~~5200002430009~~	~~01~~	~~80~~	~~CARTER OIL COAL MINE~~	~~461.2~~	~~4917.3~~		~~.~~				~~4400~~	~~1320~~					
5200002430009	02	85	CARTER OIL COAL MINE	459.4	4917.3		.				6600	1980					
5200002430009	03	85	CARTER/GASIFICATION	462.2	4917.3	300E	.	350E	1230660E		1300						
~~5200002430010~~	~~00~~		~~SUN OIL~~	~~.~~	~~.~~		~~.~~										
5200002430010	01	80	SUN OIL COAL MINE	472.8	4876.0		.				9000	1650					
5200002430010	02	85	SUN OIL COAL MINE	470.3	4876.0		.				6000	1930					
~~5201002410000~~	~~00~~			~~.~~	~~.~~		~~.~~										
5201002410000	01		CONVERSE CO. PT. SOURCES	.	.		.										
5201002410000	02			.	.		.										
~~5201002410001~~	~~00~~		~~D. JOHNSTON PP&L~~	~~.~~	~~.~~		~~.~~										
5201002410001	01	74	D. JOHNSTON PP&L/UNIT 1	436.5	4743.0	250	12.5	270	441786		7886	4912	4670	70	260	5539	3462
5201002410001	04	74	D. JOHNSTON PP&L/UNIT 2	436.5	4743.0	250	12.5	270	441786		7349	4577	4359	73	242	1247	5539
~~5201002410001~~	~~07~~	~~74~~	~~D. JOHNSTON PP&L/UNIT 3~~	~~436.5~~	~~4743.0~~	~~250~~	~~16.0~~	~~270~~	~~604779~~		~~11054~~	~~6672~~	~~6546~~	~~109~~	~~264~~	~~2371~~	~~16642~~
5201002410001	10	74	D. JOHNSTON PP&L/UNIT 4	436.5	4743.0	250	32.0	120	2412743		280	5006	8295	138	461	3374	7836
5201002410001	11	80	D. JHNST PP&L/UNITS 1,2,3	436.5	4743.0	500	28.0E	260	6750000E		3500						
~~5201002410002~~	~~00~~		~~D. JOHNSTON COAL MINE~~	~~.~~	~~.~~		~~.~~										
5201002410002	01	74	D. JOHNSTON COAL MINE	431.5	4764.5		.				3000	495					
5201002410002	02	80	D. JHNST PP&L COAL MINE	431.5	4764.5		.				9000	990					
~~5201002410003~~	~~00~~		~~PANHANDLE EASTERN~~	~~.~~	~~.~~		~~.~~										
5201002410003	01	80	PANHANDLE EASTERN/GASIF	475.2	4756.6	300	.	350	1230660		1300						
5207002430000	00			.	.		.										

I.D. NUMBER ST CO AQ PLT	PT	YR	PLANT/POINT NAME	UTM COORD,KM HORIZ	UTM COORD,KM VERT	STACK DATA HT. (FT)	STACK DATA DIA (FT)	STACK DATA TEMP (F)	STACK DATA FLOW (ACFM)	STACK DATA PLUME HT	ESTIMATED EMISSIONS, TPY PART	ESTIMATED EMISSIONS, TPY SO2	ESTIMATED EMISSIONS, TPY NOX	ESTIMATED EMISSIONS, TPY HC	ESTIMATED EMISSIONS, TPY CO	ALLOWABLE EMISS,TPY PART	ALLOWABLE EMISS,TPY SO2
5207002430000	01		SWEETWATER CO. PT. SOURCE	•	•		•										
~~5207002430000~~	~~02~~			~~•~~	~~•~~		~~•~~										
5207002430001	00		CHURCH & DWIGHT	•	•		•										
5207002430001	01	74	CHURCH & DWIGHT/SAL SODA	602.0	4605.3	60	2.0	100	17719		4					66	
~~5207002430001~~	~~02~~	~~74~~	~~CHURCH & DWIGHT/SAL SODA~~	~~602.0~~	~~4605.3~~	~~60~~	~~2.0~~	~~60~~	~~11304~~		~~3~~					~~66~~	
5207002430001	03	74	CHURCH & DWIGHT/BOILERS	602.0	4605.3	20	2.0	560	15072		0						
5207002430002	00		ALLIED CHEMICAL	•	•		•										
~~5207002430002~~	~~01~~	~~74~~	~~ALLIED/OIL-GAS BOILER~~	~~604.1~~	~~4605.4~~	~~87~~	~~5.0~~	~~350~~	~~120000~~		~~20~~	~~77~~	~~206~~	~~6~~	~~12~~		
5207002430002	05	74	ALLIED/OIL-GAS BOILER	604.1	4605.4	87	5.0	350	120000		24	62	166	5	10		
5207002430002	09	74	ALLIED/ORE CRUSHING	604.1	4605.4	59	2.2	70	17562		9						
~~5207002430002~~	~~10~~	~~74~~	~~ALLIED/ORE BINS CONVEYERS~~	~~604.1~~	~~4605.4~~	~~76~~	~~3.0~~	~~70~~	~~35000~~		~~10~~						
5207002430002	11	74	ALLIED/PRODUCT LOADING	604.1	4605.4	49	2.2	68	15500		7						
5207002430002	13		ALLIED/	604.1	4605.4		•										
~~5207002430002~~	~~13~~	~~74~~	~~ALLIED/DRYER~~	~~604.1~~	~~4605.4~~	~~100~~	~~3.5~~	~~194~~	~~18473~~		~~4~~						
5207002430002	14	74	ALLIED/DRYER	604.1	4605.4	100	3.5	194	18473		4						
5207002430002	15	74	ALLIED/DRYER	604.1	4605.4	100	3.5	194	18473		4						
~~5207002430002~~	~~16~~	~~74~~	~~ALLIED/CALCINER~~	~~604.1~~	~~4605.4~~	~~138~~	~~6.8~~	~~428~~	~~65370~~		~~25~~						
5207002430002	17	74	ALLIED/CALCINER	604.1	4605.4	138	6.8	428	65370		25						
5207002430002	18	74	ALLIED/CALCINER	604.1	4605.4	138	6.8	428	65370		25						
~~5207002430002~~	~~19~~	~~74~~	~~ALLIED/CALCINER~~	~~604.1~~	~~4605.4~~	~~138~~	~~6.8~~	~~428~~	~~65370~~		~~39~~						
5207002430002	20	74	ALLIED/CALCINER	604.1	4605.4	138	6.8	428	65370		39						
5207002430002	21	74	ALLIED/COAL FIRED BOIL"C"	604.1	4605.4	156	10.5	350	250000		261	2643	1599				
~~5207002430002~~	~~24~~	~~74~~	~~ALLIED/COAL FIRED BOIL"D"~~	~~604.1~~	~~4605.4~~	~~156~~	~~12.5~~	~~317~~	~~338000~~		~~323~~						
5207002430002	27	74	AC/HSE VENT DUST GR-I-J	604.1	4605.4	97	2.2	70	17800		9						
5207002430002	28	74	AC/PRODUCT COOLER GR-I-K	604.1	4605.4	97	1.5	194	5400		4						
~~5207002430002~~	~~29~~	~~74~~	~~AC/EVAPORAT STEAM JET 01~~	~~604.1~~	~~4605.4~~	~~72~~	~~.3~~	~~275~~	~~600~~		~~0~~						
5207002430002	30	74	AC/EVAPORAT STEAM JET 02	604.1	4605.4	72	.3	275	600		0						
207002430002	31	74	AC/PRODUCT STORAGE BINS	604.1	4605.4	76	2.8	100	25000		10						

I.D. NUMBER ST CO AQ PLT	PT	YR	PLANT/POINT NAME	UTM COORD.KM HORIZ	 VERT	----S T A C K HT. (FT)	 DIA (FT)	 TEMP (F)	D A T A----- FLOW (ACFM)	 PLUME HT	ESTIMATED EMISSIONS, TPY PART	 SO2	 NOX	 HC	 CO	ALLOWABLE EMISS,TPY PART	 SO
5207002430002	32	74	AC/DISSOLVER #1 GR-2-E	604.1	4605.4	113	1.5	185	7500		5						
~~5207002430002~~	~~33~~	~~74~~	~~AC/DISSOLVER #2 GR-2-E~~	~~604.1~~	~~4605.4~~	~~113~~	~~1.5~~	~~185~~	~~7500~~		~~5~~						
5207002430002	34	74	AC/STEAM TUBE DRY GR-2-F	604.1	4605.4	112	3.0	170	11000		1						
5207002430002	35	74	AC/STEAM TUBE DRY GR-2-G	604.1	4605.4	112	3.0	170	11000		2						
~~5207002430002~~	~~36~~	~~74~~	~~AC/STEAM TUBE DRY GR-2-H~~	~~604.1~~	~~4605.4~~	~~112~~	~~3.0~~	~~170~~	~~11000~~		~~10~~						
5207002430002	37	74	AC/HOUSE DUST VENT GR-2-J	604.1	4605.4	97	2.8	70	16000		7						
5207002430002	38	74	AC/PRODUCT COOLER GR-2-K	604.1	4605.4	97	1.5	250	5100		5						
~~5207002430002~~	~~39~~	~~74~~	~~AC/EVAPORAT STEAM JET GS~~	~~604.1~~	~~4605.4~~		~~.~~				~~0~~						
52 7002430002	40	74	AC/VAC PMP DEAER GR-2-M	604.1	4605.4		.				0						
5207002430002	41	74	AC/CRUSH & SCREEN GR-3-A	604.1	4605.4	60	3.2	68	32000		14						
~~5207002430002~~	~~42~~	~~74~~	~~AC/ORE CONVEYOR GR-3-B~~	~~604.1~~	~~4605.4~~	~~100~~	~~.7~~	~~68~~	~~1500~~		~~1~~						
5207002430002	43	74	AC/ORE BIN GAL GR-3-C	604.1	4605.4	130	1.2	68	6000		3						
5207002430002	44	74	AC/CALCINER GR-3-D	604.1	4605.4	130	6.0	360	150000		136					136	
~~5207002430002~~	~~45~~	~~76~~	~~AC/CALCINER GR-3-E~~	~~604.1~~	~~4605.4~~	~~130~~	~~6.0~~	~~360~~	~~150000~~		~~136~~					~~136~~	
5207002430002	46	76	AC/DISSOLVER VENT GR-3-F	604.1	4605.4	130	1.7	185	12000		1						
5207002430002	47	76	AC/DISSOLVER VENT GR-3-G	604.1	4605.4	130	1.7	185	12000		1						
~~5207002430002~~	~~48~~	~~76~~	~~AC/FILTER AID GR-3-H~~	~~604.1~~	~~4605.4~~	~~130~~	~~1.0~~	~~68~~	~~600~~		~~1~~						
5207002430002	49	76	AC/ML FLASH DEAER GR-3-J	604.1	4605.4	110	.3	149	34		0						
5207002430002	50	76	AC/STEAM TUBE DRY GR-3-K	604.1	4605.4	110	3.0	194	15000		1						
~~5207002430002~~	~~51~~	~~76~~	~~AC/STEAM TUBE DRY GR-3-L~~	~~604.1~~	~~4605.4~~	~~110~~	~~3.0~~	~~194~~	~~15000~~		~~1~~						
5207002430002	52	76	AC/STEAM TUBE DRY GR-3-M	604.1	4605.4	110	3.0	194	15000		1						
5207002430002	53	76	AC/STEAM TUBE DRY GR-3-N	604.1	4605.4	110	3.0	194	15000		1						
~~5207002430002~~	~~54~~	~~76~~	~~AC/STEAM TUBE DRY GR-3-P~~	~~604.1~~	~~4605.4~~	~~110~~	~~3.0~~	~~194~~	~~15000~~		~~1~~						
5207002430002	55	76	AC/DRYER VENT GR-3-R	604.1	4605.4	110	2.5	194	12000		1						
5207002430002	56	76	AC/PRODUCT COOLER GR-3-S	604.1	4605.4	110	1.5	194	9000		1						
~~5207002430002~~	~~57~~	~~76~~	~~AC/PRODUCT COOLER GR-3-T~~	~~604.1~~	~~4605.4~~	~~110~~	~~1.5~~	~~194~~	~~9000~~		~~1~~						
5207002430002	58	74	AC/HOUSEKEEPING GR-3-U	604.1	4605.4	110	2.8	68	25000		22						
5207002430002	59	74	AC/HOUSEKEEPING GR-3-V	604.1	4605.4	110	2.8	68	25000		22						

I.D. NUMBER ST CO AQ PLT	PT	YR	PLANT/POINT NAME	UTM COORD.KM HORIZ	 VERT	----S T A C K D A T A---- HT. (FT)	 DIA (FT)	 TEMP (F)	 FLOW (ACFM)	 PLUME HT	ESTIMATED EMISSIONS, TPY PART	 SO2	 NOX	 HC	 CO	ALLOWABLE EMISS,TPY PART	 SO2
5207002430003	00		STAUFFER CHEMICAL	.	.		.										
~~5207002430003~~	~~01~~	~~74~~	~~STAUFFER/OIL-NAT GAS BOIL~~	~~608.8~~	~~4619.0~~	~~50~~	~~4.5~~	~~360~~	~~25765~~		~~6~~	~~302~~	~~43~~	~~1~~	~~3~~		
5207002430003	04	74	STAUFF/OIL-NAT GAS BOILER	608.8	4619.0	50	5.0	360	25765		6	351	43	1	3		
5207002430003	07	74	STAUFF/OIL-NAT GAS BOILER	608.8	4619.0	50	5.0	480	28274		0	0	0	0	0		
~~5207002430003~~	~~10~~	~~74~~	~~STAUFF/OIL-NAT GAS BOILER~~	~~608.8~~	~~4619.0~~	~~55~~	~~6.5~~	~~321~~	~~55748~~		~~16~~	~~808~~	~~109~~	~~3~~	~~6~~		
5207002430003	13	74	STAUFF/OIL-NAT GAS BOILER	608.8	4619.0	80	6.0	333	52590		13	922	87	2	5		
5207002430003	16	74	STAUFF/OIL-NAT GAS BOILER	608.8	4619.0	80	6.0	321	50894		17	714	104	3	7		
~~5207002430003~~	~~19~~	~~74~~	~~STAUFFER/ [illegible] CALCINER~~	~~608.8~~	~~4619.0~~	~~100~~	~~6.0~~	~~370~~	~~120109~~		[illegible]					~~163~~	
5207002430003	20	74	STAUFF/UNIT 1&2 CALCINERS	608.8	4619.0	100	6.0	370	122993		29					161	
5207002430003	21	74	STAUFFER/UNIT 4 CALCINER	608.8	4619.0	75	9.0	165	114511		203					228	
~~5207002430003~~	~~22~~	~~74~~	~~STAUFFER/1&2 DRYER-COOLER~~	~~608.8~~	~~4619.0~~	~~100~~	~~6.0~~	~~305~~	~~125877~~		~~117~~					~~180~~	
5207002430003	23	74	STAUFFER/#3 DRYER-COOLER	608.8	4619.0	100	6.0	305	116716		23					150	
5207002430003	24	74	STAUFFER/UNIT 4 DRYER	608.8	4619.0	100	5.5	150	84389		194					223	
~~5207002430003~~	~~25~~	~~74~~	~~STAUFFER/UNIT 4 COOLER~~	~~608.8~~	~~4619.0~~	~~100E~~	~~5.5E~~	~~140E~~	~~84389E~~		~~2~~					~~211~~	
5207002430003	26	76	STAUFFER/UNIT 4A CALCINER	608.8	4619.0	80E	9.0E	165E	114511E		26					165	
5207002430003	27	77	STAUFFER/UNIT 5 CALCINER	608.8	4619.0	80E	9.0E	370E	122993E		142					173	
~~5207002430003~~	~~28~~	~~76~~	~~STAUFFER/4A DRYER-COOLER~~	~~608.8~~	~~4619.0~~	~~60E~~	~~6.0E~~	~~305E~~	~~116716E~~		~~2~~					~~150~~	
5207002430003	29	77	STAUFFER/5 DRYER-COOLER	608.8	4619.0	80E	6.0E	305E	116716E		9					176	
5207002430004	00		FMC	.	.		.										
~~5207002430004~~	~~01~~	~~74~~	~~FMC/OIL-NAT GAS BOILER~~	~~598.8~~	~~4600.6~~	~~100~~	~~9.0~~	~~560~~	~~108786~~		[illegible]	~~136~~	~~261~~	~~6~~	~~30~~		
5207002430004	03	74	FMC/OIL-NAT GAS BOILER	598.8	4600.6	70	6.5	360	44996		21	69	148	3	10		
5207002430004	05	74	FMC/OIL-NAT GAS BOILER	598.8	4600.6	78	7.5	250	72629		41	136	289	6	19		
~~5207002430004~~	~~06~~	~~74~~	~~FMC/OIL-NAT GAS BOILER~~	~~598.8~~	~~4600.6~~	~~60~~	~~6.0~~	~~330~~	~~40715~~		~~36~~	~~43~~	~~226~~	~~4~~	~~16~~		
5207002430004	13	74	FMC/TRONA DUST COLLECT	598.8	4600.6	77	2.3	133	2863		4						
5207002430004	14	74	FMC/TRONA DUST COLLECT	598.8	4600.6	78	2.3	133	2863		4						
~~5207002430004~~	~~15~~	~~74~~	~~FMC/DISSOLVER-TRONA [illegible]~~	~~598.8~~	~~4600.6~~	~~75~~	~~1.0~~	~~175~~	~~990~~		~~3~~						
5207002430004	16	74	FMC/DISSOLVER	598.8	4600.6	35	1.0	175	990		3						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.0	175	[illegible]		3						

I.D. NUMBER				UTM COORD,KM		STACK DATA					ESTIMATED EMISSIONS, TPY					ALLOWABLE EMISS,TPY	
ST CO AQ PLT	PT	YR	PLANT/POINT NAME	HORIZ	VERT	HT. (FT)	DIA (FT)	TEMP (F)	FLOW (ACFM)	PLUME HT	PART	SO2	NOX	HC	CO	PART	SO2
5207002430004	18	74	FMC/DISSOLVER	598.8	4608.6	75	1.0	175	990		3						
~~5207002430004~~	~~19~~	~~74~~	~~FMC/DRYER~~	~~598.8~~	~~4608.6~~	~~35~~	~~1.5~~	~~165~~	~~11239~~		~~34~~					~~109~~	
5207002430004	20	74	FMC/DUST COLLECTION	598.8	4608.6	30	1.3	60	6371		2						
5207002430004	21	74	FMC/STEAM TUBE CALCINER	598.8	4608.6	68	2.5	180	22001		11					155	
~~5207002430004~~	~~22~~	~~74~~	~~FMC/CALCINER~~	~~598.8~~	~~4608.6~~	~~72~~	~~2.5~~	~~180~~	~~17024~~		~~4~~					~~125~~	
5207002430004	23	74	FMC/CALCINER	598.8	4608.6	72	2.5	180	17024		3					85	
5207002430004	24	74	FMC/CALCINER	598.8	4608.6	72	2.5	180	17024		5					144	
~~5207002430004~~	~~25~~	~~74~~	~~FMC/GAS FIRE CALCIN RA-22~~	~~598.8~~	~~4608.6~~	~~64~~	~~3.5~~	~~142~~	~~21936~~		~~28~~					~~44~~	
5207002430004	26	74	FMC/GAS FIRE CALCIN RA-22	598.8	4608.6	64	3.5	144	21243		40					44	
5207002430004	27	74	FMC/GAS FIRE CALCIN RA-23	598.8	4608.6	80	2.5	135	34754		65					78	
~~5207002430004~~	~~28~~	~~74~~	~~FMC/GAS FIRE CALCIN RA-23~~	~~598.8~~	~~4608.6~~	~~80~~	~~2.5~~	~~135~~	~~34754~~		~~65~~					~~78~~	
5207002430004	29	74	FMC/GAS FIRE CALCIN RA-24	598.8	4608.6	42	1.5	130	12724		81					92	
5207002430004	30	74	FMC/GAS FIRE CALCIN RA-24	598.8	4608.6	42	1.5	130	12724		89					92	
~~5207002430004~~	~~31~~	~~74~~	~~FMC/FLUID BED CALCINER~~	~~598.8~~	~~4608.6~~	~~88~~	~~5.0~~	~~140~~	~~82565~~		~~85~~					~~177~~	
5207002430004	32	74	FMC/DUST COLLECTION	598.8	4608.6	95	2.5	77	12076		3						
5207002430004	33	74	FMC/DUST COLLECTION	598.8	4608.6	59	4.0	75	29828		12						
~~5207002430004~~	~~34~~	~~74~~	~~FMC/PHOSPHORUS FURNACE~~	~~598.8~~	~~4608.6~~	~~110~~	~~3.5~~	~~167~~	~~51377~~		~~71~~					~~120~~	
5207002430004	35	74	FMC/SPRAY DRYER	598.8	4608.6	122	3.0	104	42412		78					136	
5207002430004	36	74	FMC/DUST COLLECTION STPP	598.8	4608.6	168	.7	80E	7359E		1						
~~5207002430004~~	~~37~~	~~74~~	~~FMC/DUST COLLECTION STPP~~	~~598.8~~	~~4608.6~~	~~120~~	~~1.4~~	~~80~~	~~7359~~		~~15~~						
5207002430004	38	74	FMC/CALCINER	598.8	4608.6	58	2.5	140	22855		6					44	
5207002430004	39	74	FMC/DUST COLLECTION	598.8	4608.6	58	2.0	100	11006		17						
~~5207002430004~~	~~40~~	~~74~~	~~FMC/TRONA COOLER~~	~~598.8~~	~~4608.6~~	~~50~~	~~1.9~~	~~167~~	~~4100~~		~~12~~					~~35~~	
5207002430004	41	74	FMC/DUST COLLECT MCMO-2	598.8	4608.6	65	2.0	57	20923		10						
5207002430004	42	74	FMC/DUST COLLECTION	598.8	4608.6	65	2.0	70	12742		8						
~~5207002430004~~	~~43~~	~~74~~	~~FMC/DUST COLLECTION~~	~~598.8~~	~~4608.6~~	~~106~~	~~3.7~~	~~63~~	~~19483~~		~~2~~						
5207002430004	44	74	FMC/CALCINER	598.8	4608.6	95	5.0	162	92834		127					214	
5207002430004	45	74	FMC/DRYER	598.8	4608.6	95	5.0	140	70332		16					188	

I.D. NUMBER ST CO AQ PLT	PT	YR	PLANT/POINT NAME	UTM COORD,KM HORIZ	UTM COORD,KM VERT	STACK DATA HT. (FT)	STACK DATA DIA (FT)	STACK DATA TEMP (F)	STACK DATA FLOW (ACFM)	STACK DATA PLUME HT	ESTIMATED EMISSIONS, TPY PART	ESTIMATED EMISSIONS, TPY SO2	ESTIMATED EMISSIONS, TPY NOX	ESTIMATED EMISSIONS, TPY HC	ESTIMATED EMISSIONS, TPY CO	ALLOWABLE EMISS,TPY PART	ALLOWABLE EMISS,TPY SO2
5207002430004	46	74	FMC/DUST COLLECTION	598.8	4608.6	70	3.0	180	17262		2						
~~5207002430004~~	~~47~~	~~76~~	~~FMC/2 883MM COAL BOILERS~~	~~598.8~~	~~4608.6~~	~~390~~	~~16.~~	~~332~~	~~744331~~		~~774~~	~~3282~~	~~5415~~			~~774~~	~~3282~~
5207002430004	50	76	FMC/COAL PULVERIZING NS2	598.8	4608.6	120	1.0	70	1611		3						
5207002430004	51	76	FMC/CALCINER NEW NS3	598.8	4608.6	95	7.8	150	140766		153					173	
~~5207002430004~~	~~52~~	~~76~~	~~FMC/CALCINER NEW NS4~~	~~598.8~~	~~4608.6~~	~~106~~	~~4.7~~	~~63~~	~~40390~~		~~4~~						
5207002430004	53	76	FMC/DISSOVER NS5	598.8	4608.6	100	2.5	70	20411		12						
5207002430004	54	76	FMC/DRYER NS6	598.8	4608.6	95	6.5	140	101938		29					164	
~~5207002430004~~	~~55~~	~~76~~	~~FMC/COAL UNLOADING NS7~~	~~598.8~~	~~4608.6~~	~~35~~	~~1.8~~	~~70~~	~~6711~~		~~10~~						
5207002430004	56	76	FMC/STOCKPILING NS8	598.8	4608.6	60	2.5	70	13430		12						
5207002430005	00		JIM BRIDGER POWER PLANT	.	.		.										
~~5207002430005~~	~~01~~	~~74~~	~~J. BRIDGER PP&L/BOILER #1~~	~~684.7~~	~~4623.5~~	~~500~~	~~24.0~~	~~240~~	~~2103610~~		~~339~~	~~4269~~	~~4032~~	~~81~~	~~269~~	~~582~~	~~1506~~
5207002430005	04	75	J. BRIDGER PP&L/BOILER #2	684.7	4623.5	500	24.0	240	2103610		339	4269	4032	81	269	582	1506
5207002430005	07	77	J. BRIDGER PP&L/BOILER #3	684.7	4623.5	500	24.0	240	2103610		339	4269	4032	81	269	582	1506
~~5207002430006~~	~~00~~		~~GUNN QUEALY~~	.	.		.										
5207002430006	01	74	GUNN QUEALY SALEM COKER	.	.	130	15.0	1830	584483								
5207002430007	00		TEXASGULF	.	.		.										
~~5207002430007~~	~~01~~	~~76~~	~~TEXASGULF/CONVEYOR TRANS~~	~~592.0~~	~~4613.5~~	~~60~~	~~3.5~~	~~45E~~	~~15000~~		~~6~~						
5207002430007	02	76	TEXASGULF/STOCKPILE	592.0	4613.5	40	2.1	45E	10000		4						
5207002430007	03	76	TEXASGULF/SCRNS & CRUSHR	592.0	4613.5	90	3.3	45E	25000		9						
~~5207002430007~~	~~04~~	~~76~~	~~TEXASGULF/2 CALCINERS~~	~~592.0~~	~~4613.5~~	~~130~~	~~12.0~~	~~450~~	~~402000~~		~~181~~					~~182~~	
5207002430007	06	76	TEXASGULF/2 DRYERS	592.0	4613.5	90	5.0	200	50000		19					142	
5207002430007	07	76	TEXASGULF/STEENS STORAGE	592.0	4613.5	90	2.0	45E	20000		9						
~~5207002430007~~	~~08~~	~~76~~	~~TEXASGULF/2 BOILERS~~	~~592.0~~	~~4613.5~~	~~130~~	~~10.7~~	~~220~~	~~210000~~		~~282~~	~~3306~~				~~282~~	~~3306~~

A-7

APPENDIX B

DEVELOPMENT OF A PARTICULATE EMISSION FACTOR FOR SURFACE MINING IN THE POWDER RIVER BASIN OF WYOMING

DEVELOPMENT OF A PARTICULATE EMISSION FACTOR FOR SURFACE MINING IN THE POWDER RIVER BASIN OF WYOMING

In developing an emission factor to estimate particulate emissions from strip mining activity in the Powder River Basin of Wyoming, three previously estimated emission factors for surface mines were reviewed. Two factors, originally developed by Hittman Associates and Battelle Memorial Institute, were obtained from a report used to compare energy alternatives in environmental impact statements.[1] Hittman calculated a particulate emission factor for surface mining for five geographic regions in the U.S. using two sources of emissions--diesel-fueled mining equipment and wind erosion. Battelle calculated overall particulate emission factors for surface mining for two geographic regions in the U.S. based on 0.1 pound of particulate per ton of overburden removed (with the assumption that overburden removal was the primary source of particulate).

A third value, developed by PEDCo-Environmental for a single lignite surface mine in North Dakota, was used to compare the Hittman and Battelle factors. PEDCo estimated particulate emissions by the following procedure: (1) observe mining operation; (2) identify significant emission-producing activities; (3) determine operational parameters related to the amount of emissions generated; and (4) obtain operational data for these parameters. Eight significant source areas were identified: scrapers, dragline operation, haul road traffic, haul road construction and repair, shovels and front-end loaders, truck dump at hopper, vehicle exhaust, and wind erosion of exposed soil. Emissions were estimated separately for each of these source areas. Total emissions were divided by tons of coal mined to obtain an emission factor in pounds per ton of coal mined.

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[1] University of Oklahoma, Science and Public Policy Program, Energy Alternatives: A Comparative Analysis, prepared for CEQ, ERDA, EPA, FEA, FPC, DOI, and NSF, Washington D.C., May 1975.

Table 1 shows the three emission factors according to source of information, geographic region, and assumed control.

Table 1. PARTICULATE EMISSION FACTOR FOR SURFACE MINING

Source	Geographic region	Assumed control	Emission factor
Hittman	Northwest	Wind erosion: 5 years reclamation	0.84 ton/10^{12} Btu
Battelle	West	Wind erosion: 3 years reclamation	35 ton/10^{12} Btu
PEDCo	North Dakota lignite mine	Wind erosion: 3 years reclamation; Dust: watering	0.72 lb/ton of coal mined, 30 ton/10^{12} Btu

The Division of Air Quality, Wyoming Department of Environmental Quality, analyzed the above factors to see if any were applicable to the surface mining conditions which exist in the Powder River Basin. The PEDCo factor of 0.72 pounds per ton was converted to 30 tons per 10^{12} Btu by using 6,000 Btu per pound of lignite coal for the North Dakota surface mine. Thus, all factors were in the same units; i.e. tons per 10^{12} Btu. The Hittman factor was substantially less (35-40 times less) than the Battelle and PEDCo factors and, consequently, was deleted from further investigation.

Although the PEDCo and Battelle factors appeared to be in reasonable agreement, no direct comparison can be made.

The reason is that each emission factor is dependent upon the overburden depths, coal seam thicknesses, reclamation rates, and disturbed surface areas associated with each mine. Therefore, the fugitive dust emission rate per 10^{12} Btu is a meaningless number.

Because of the detailed analysis used in developing PEDCo factors, the Division compared surface mining conditions in North Dakota with those occurring for the "typical" Powder River surface mine. The PEDCo factor was based on an overburden depth of 65 feet and a disturbed surface area of 300 acres per year.

The overburden depth in the Powder River Basin varies from 5 to 250 feet with an average overburden depth of about 100 feet and average disturbed surface area of about 100 acres per year. In North Dakota the lignite seam was 10 feet in thickness, while the Powder River Basin seams vary from 8 to 75 feet.

Due to the large variation in the Powder River Basin coal seams, the Division, using the individual emission factors in the PEDCo study, developed the following Powder River Basin emission factors.

Table 2. POWDER RIVER BASIN EMISSION FACTORS

Seam thickness, ft.	Production, 10^6 ton/yr	Emission factors, lb/ton, mined
10	2.61	1.38
35	9.15	0.33
75	19.60	0.15

The forecasted production rates in Table 3.1 of the Powder River Basin coal mines indicated the 9 million tons per year per 100 acres was a reasonable estimate. Therefore, the emission factor of 0.33 lb/ton of coal mined was used to determine the particulate emission for the projected surface mining activity in the Powder River Basin Air Quality Maintenance Area.

The following are the calculations used to derive the Powder River Basin emission factor:

Estimated Coal Removal from a 35 foot Coal Seam

Assume: Surface area = 100 acres
Unit weight = 120 lb/cu ft

$$(100A)(35ft)(43560ft^2/A)(yd^3/27ft^3) = 5.65x10^6yd^3/yr$$

$$(5.65x10^6yd^3/yr)(^{120\#}/ft^3)(^{27ft^3}/yd^3)(^{1ton}/2000\#) =$$
$$\underline{9.15x10^6ton/yr}$$

Powder River Basin Mining Activities

1) Dragline Operation

Estimated Overburden Removal = 100 ft

Estimated Surface Area Disturbed (per yr per mine) = 100 Acres

$$(100A)\ \left(43560\ \frac{ft^2}{A}\right)\ \left(\frac{1\ yd^2}{9\ ft^2}\right) = 484{,}000 yd^2$$

Estimated Overburden Volume

$$(100ft)\ \left(\frac{1yd}{ft}\right)\ (484{,}000yd^2) = 1.61\times10^6 yd^3$$

$$\left(\frac{1.5 Ton}{yd^3}\right)\ (1.61\times10^6 yd^3) = 2.42\times10^6 Tons$$

Emission Rate = 0.05 #/Ton

Emission = $(2.42\times10^6$ Tons) (0.05 #/Ton) = **605 Tons/yr**

2) Scrapers

(3 scrapers) (21 hr/day) (32 lb/hr) (0.5 control factor) = 0.504 Tons/day

Operation on day w/o snow or rain (May through November) = 115 day/yr

(0.504 Ton/day) (115 day/yr) = **58 Tons/yr**

3) Haul Road Traffic

Average weight per truckload = $\frac{5(45) + 3(200)}{8}$ = 103 Tons

Truckloads per year = 9.15×10^6 Tons/103 Tons = 88835 per year
= 244 per day

Average Round-trip Distance = 4 miles

VMT/yr = (4mi) (88835 trips) = 355,000 VMT/yr

Water Truck = (8hr/day) (166 day/yr) (12mph) = 16,000 VMT/yr

Pickups = (2 pickups) (8 hr/day) (166 day/yr) (20mph) = 53,000 VMT/yr

Emission Factor = $(0.6)\ (0.81)\ (s)\ (S/30)\ \left(\frac{365-W}{365}\right)\ (2.5)\ (0.5)$

Where: s = 12% S = 20mph W = 199

Emission Factor (Haul Trucks) = 2.2 lb/VMT

Emission Factor (Pickups) = 0.9 lb/VMT

Emission = (355,000 VMT/yr) (2.2) + (53,000 VMT/yr) (0.9) = 414 Ton/yr

4) Haulroad Construction and Repair

(2 graders) (8 hr/day) (32 lb/hr) (0.5 control factor) = 0.128 Ton/day

Operation: Only on days with no snow or rain = 166 day/yr

Emissions + (0.128 T/day) (166 day/yr) = 21 Ton/yr

5) Shovels and Front-end Loaders

Emissions = (0.02 lb/Ton) (1 Ton/2,000#) ($9.15x10^6$ Ton) = 92 Ton/yr

6) Trucks Dumping at Hopper

Emissions = (0.02 lb/Ton) (1 Ton/2,000#) ($9.15x10^6$Ton) = 92 Ton/yr

7) Vehicle Exhaust

Assume: 6- 45 Ton Trucks
3-200 Ton Trucks

Deisel Fuel Usage = 15gal/hr (6- 45)
= 30gal/hr (3-200)

Emission Factor = 25 lb/1,000gal

Total Haul Truck Usage = (1)(15)(8)(116) + 5(15)(25)(356) + 3(30)(24)(356)

= 1,456,320 gal/yr

Emissions = (1,465,320 gal/yr) (251g/1,000gal) = 18 Ton/yr

Pickup Usage = $\frac{(53,000 \text{ VMT/yr})}{(454\text{gram/\#})} \frac{(0.34 \text{ gram/mi})}{(2,000\text{lb/ton})}$ = negligible

Scrapers, graders = loaders

(3 scrapers)(21hr/day)(115day/yr)(0.061#/hr) + (2 graders)(8hr/day)(166day/yr)
(0.061 lb/hr) + (2 loaders)(21hr/day)(365 days/yr)(0.165 lb/hr)

Emissions = 2 Tons/yr

Total Vehicle Exhaust Emissions = 18+2 = 20 Tons/yr

8) Wind Erosion of Exposed Soil

$E = 0.025\ I\ K\ C\ L'\ V'$

I = 47 ton/A/yr (clay-loam soil)
K = 1.0 (unridged surface)
L = 0.25
L' = 2,000'
V' = 1.0

Emissions = 0.25 Ton/yr/A

Assuming: 3 years prior to land reclamation a total of 800 A (probably 300A in PRB) would be subject to wind erosion.

Emissions - (0.24 Ton/yr/A) (800A) = **193 Tons/yr**

Total Emissions for a "typical" PRB mine

605 Tons/yr
58 "
414 "
21 "
92 "
92 "
20 "
193 "
1,495 Tons/yr

$$\text{35 Foot Seam Emission Factor} = \frac{(1{,}495\text{Ton/yr})}{(9.15\text{x}10^{6}\ \text{Ton/yr})}\ (2{,}000\text{lb/ton}) = 0.33\ \frac{\text{lb}}{\text{Ton-Mined}}$$

APPENDIX C

WYOMING AIR QUALITY AND METEOROLOGICAL DATA

Sampling Network Description

Pollutants: Total Suspended Particulates
AQMA: Powder River Basin

Sampling Location	Operator	UTM Coordinates		Dates of Operation	Comments
		HOR	VERT		
Douglas	Wyoming AQD	449.5	4743.7	Jan 1973-present	
Stoddard Ranch	Wyoming AQD	467.5	4806.0	Jan 1974-present	
Gillette	Wyoming AQD	460.0	4904.1	Jun 1972-present	
Reno Junction	Wyoming AQD	463.0	4850.0	Feb 1974-present	
Gillette	NGPRP	460.0	4897.0	Sep 1974-present	Also, Cascade impactor
Douglas Plant Site	Panhandle Eastern	449.0	4744.0	Jan 1974-Jun 1974	Also, Ozone and HC analyzers

Air Quality Data Summary

Pollutants: Total Suspended Particulates

AQMA: Powder River Basin

Sampling Site	Year	# of Samp	Geometric Mean, ug/m^3					24 Hour Maximum, ug/m^3			
			Annual (GM/GSD)	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
State:											
Douglas	74	52	55/1.74	61	55	42	62	98	79	63	231
Stoddard Ranch	74	44	23/1.36	19	34	25	18	38	80	89	47
Gillette	74	19	31/1.49	29	34	--	36	118	--	--	70
Reno Junction	74	52	48	53	39	54	51	128	94	155	119
Other:											
Gillette	74	15	---	--	--	--	11	--	--	--	27
Douglas Plant Site	74	33	---	10.1	19.0	--	--	16.0	73.0	--	--

Sampling Network Description

Pollutants: Total Suspended Particulates
AQMA: Sweetwater County

Sampling Location	Operator	UTM Coordinates		Dates of Operation	Comments
		HOR	VERT		
Green River	Wyoming AQD	628.2	4598.5	Jan 1974-present	
Granger	Wyoming AQD	585.9	4604.8	Mar 1973-present	
Rock Springs Alder	Wyoming AQD	649.3	4603.5	Jan 1974-present	
Rock Springs Logan	Wyoming AQD	647.7	4606.4	Jan 1974-present	
Rock Springs Fearn	Wyoming AQD	648.0	4605.7	Jun 1972-present	
Green River	FMC			Sep 1974-present	Five hi-vol sites sampling every day; have raw data for 3 sites. Source oriented.
Site 2		597.1	4608.1		
Site 3		599.8	4607.9		
Site 4		600.3	4608.3		
Site 5		600.2	4607.1		
Site 6		599.1	4607.8		

Sampling Network Description (continued)

Pollutants: Total Suspended Particulates

AQMA: Sweetwater County

Sampling Location	Operator	UTM Coordinates		Dates of Operation	Comments
		HOR	VERT		
Green River Works	Allied Chemical				Four hi-vol sites, sampling every 6 days. Source oriented.
Site 1		605.0	4605.5	Aug 1973-present	
Site 2		605.8	4605.3	May 1974-present	
Site 3		602.5	4604.5	Jan 1974-present	
Site 4		603.9	4606.4	May 1974-present	
Jim Bridger Project	Pacific Power and Light			Apr 1971-present	Three hi-vol sites from April 1971 to June 1974. Five hi-vol sites from June 1974 on. Sampling twice per month until May 1974, every 6 days thereafter. Plant start-up August 1974. Source oriented.
Plant Site		684.7	4623.5		
Superior Wells		679.0	4627.0		
Microwave Tower		700.8	4619.8		
Bluff					
Point of Rocks					

Air Quality Data Summary

Pollutants: Total Suspended Particulates

AQMA: Sweetwater County

Sampling Site	Year	# of Samp	Geometric Mean, ug/m^3					24 Hour Maximum, ug/m^3			
			Annual	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qt
State:											
Green River	74	53	65	54	77	77	55	262	195	175	113
Granger	74	53	54	27	86	91	45	62	209	199	131
Rock Springs											
Alder	74	42	39	23	53	67	44	52	155	173	101
Logan	74	52	74	65	85	97	56	138	255	186	107
Fearn	74	51	115	67	118	140	151	205	295	300	347
Other:											
FMC Green River											
Site 2	74	91[a]	---	---	---	---	35	---	---	---	126
Site 3	74	91	---	---	---	---	205	---	---	---	618
Site 4	74	91	---	---	---	---	132	---	---	---	456
Site 5	74	91	---	---	---	---	59	---	---	---	220
Site 6	74	91	---	---	---	---	276	---	---	---	---
Allied Green River Works											
Site 1	74	31[b]	124	114	162	---	83	---	284	---	218
Site 2	74	25	---	---	---	---	91	---	196	---	351
Site 3	74	29	49	44	67	---	42	---	271	---	138
Site 4	74	27	---	---	---	---	49	---	123	---	166

Air Quality Data Summary (continued)

Pollutants: Total Suspended Particulates

AQMA: Sweetwater County

Sampling Site	Year	# of Samp	Geometric Mean, ug/m^3					24 Hour Maximum, ug/m^3			
			Annual	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Jim Bridger Project											
Plant Site	74	10[c]	---	32	140	---	---	349	931	---	---
Superior Wells	74	10	---	14	30	---	---	20	117	---	---
MicrowaveTower	74	10	---	12	4	---	---	26	8	---	---

[a] 3 months (October-December).

[b] 9 months, no data for June-August.

[c] 5 months (January-May), 2 samples/month.

Sampling Network Description

Pollutants: SO_2
AQMA: Sweetwater County

Sampling Location	Operator	UTM Coordinates		Dates of Operation	Comments
		HOR	VERT		
Rock Springs Fearn	Wyoming AQD	648.0	4605.7	Jun 1972-present	Bubbler, urban background.
FMC Green River Site 3	FMC	600.3	4608.3	Sep 1974-present	One continuous SO_2 analyzer Questionable data. Source oriented.
Green River Works	Allied Chemical			Oct 1974-present	Two sampling sites with a continuous SO_2 analyzer. Show negligible concentrations. Source oriented.
Site 2		605.0	4605.5		
Site 4		603.9	4606.4		
Jim Bridger Project	Pacific Power and Light			Apr 1971-present	Three sample sites from April 1971 to June 1974, intermittant SO_2 sampling. Five sampling sites from June 1974 on with continuour SO_2 analyzers. Plant start-up August 1974. Source oriented.
Plant Site		684.7	4623.5		
Superior Wells		679.0	4627.0		
MicrowaveTower		700.8	4619.8		
Bluff					
Point of Rocks					

Air Quality Data Summary

Pollutants: SO_2

AQMA: Sweetwater County

Sampling Site	Year	# of Samp	Units/ Method	Arithmetic Mean					24 Hour Maximum			
				Annual	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Rock Springs--Fearn	74	46	ugm/m^3 24 hour bubbler	1.0	1.0	.33	2.1	.77	9.0	2.0	10.0	5.0
FMC Green River	74	240[a]	ugm/m^3 continuous	---	---	---	---	51.0	---	---	---	104.0
Allied Green River Works Pos. II	74	2160[b]	ppm/ continuous	---	---	---	---	0.00	---	---	---	0.00
Pos. IV	74	2160[b]	ppm/ continuous	---	---	---	---	0.00	---	---	---	0.00
Jim Bridger Project	74	---[c]	ppm/ continuous	negligible concentrations								

[a] 10 days of hourly averages (December 16 to December 27).

[b] 90 days of hourly averages (October-December).

[c] Before plant start-up (January-May).

PARTICULATE SAMPLING DATA USED IN AQDM MODELING

AQMA/Sampler	No. of samples	Arith mean	Geom mean	Max 24 hr	Std geom deviation
Powder River Basin					
Gillette Area:					
Gillette[a]	19	37	31	118	1.49
Reno Junction Area:					
Stoddard Ranch[a]	44	27	23	89	1.36[b]
Reno Junction[a]	52	56	48	155	1.74[b]
Reno Junction[c]	50	36	28	131	-
Douglas Area:					
Douglas[a]	52	62	55	231	1.74
Douglas[c]	55	42	35	159	-
Sweetwater					
Trona Plant Area:[d]					
Granger	54	66	46	209	2.34[b]
Allied - 1	31	120	97	468	1.92[b]
Allied - 2	24	93	64	351	2.37[b]
Allied - 3	29	87	39	1004	3.54[b]
Allied - 4	23	61	44	199	2.24[b]

[a] January 1974 to December 1974.

[b] Calculated using log normal distribution.

[c] January 1975 to December 1975.

[d] April 1974 to March 1975.

Wyoming AQMA Meteorological Data

Location	Operator	Dates of Operation	Wind Speed	Wind Dir	Sensor Height	Mixing Height	Comments
Powder River Basin							
Dave Johnson Power Plant-Douglas	Pacific Power and Light	Jan 74-present	cont	cont	33 feet 140 feet	tower	
Douglas Plant Site-South	Panhandle Eastern	Dec 74-present	cont	cont	33 feet 140 feet	tower	
Douglas Plant Site-North	Panhandle Eastern	Jul 74-present	cont	cont	33 feet 140 feet	tower	
Rochelle Mine	Panhandle Eastern	Jun 73-Jun 74	cont	cont	10 feet	N/A	
Moorcroft	Synoptic Observation Station	?	--	--	--	N/A	STAR prog 1950-1952 24 obs/day
Sheridan Airport	National Weather Service	Prior to 1949-present	--	--	--	N/A	STAR prog 1949-1953 8 obs/day
Casper Airport	National Weather Service	Prior to 1967-present	--	--	--	N/A	STAR prog 1967-1971 8 obs/day
Sweetwater							
Rock Springs Airport	FAA	Prior to 1967-present	--	--	--	N/A	STAR prog 1967-1971 8 obs/day
Green River	FMC	Sep 74-present	cont	cont	N/A	N/A	
Green River Works	Allied Chemical	Jan 74-present	cont	cont	N/A	N/A	
Jim Bridger	Pacific Power and Light	Sep 70-present	cont	cont	20 feet 200 feet	tower	

cont = continuous; N/A = not available

APPENDIX D

ROCK SPRINGS AND GREEN RIVER EMISSION INVENTORY AND EMISSION DENSITY

Table D.1. ROCK SPRINGS EMISSION INVENTORY AND EMISSION DENSITY

Source category	Emission factor	Parameters	Particulate emissions, ton/yr				
			1974	GF[a]	1980	GF	1985
Fugitive dust							
Unpaved roads							
County roads	5.8000 #/VMT	40 VMT/day; 248 day/yr	29	1.38	40	1.51	44
City streets	5.8000 #/VMT		--		--		--
Local streets	1.9000 #/VMT		--		--		--
Alleys	1.9000 #/VMT		--		--		--
Paved roads							
Winter sanding	0.1700 #/VMT	12703 VMT/day; 20 day/yr	22	1.38	30	1.51	33
Cleaned roads	0.0038 #/VMT	7622 VMT/day; 228 day/yr	3	1.38	4	1.51	5
Uncleaned roads	0.0600 #/VMT	7622 VMT/day; 228 day/yr	52	1.38	72	1.51	79
Unpaved shoulders	1.9000 #/VMT		--		--		--
Construction	1.06 ton/ac/mo	6 acres; 3 months	19	1.50	29	1.60	30
Other							
Fuel combustion	--	grid/county pop, .03[b]	3	1.50	5	1.60	5
Highway vehicles	--	grid/county VMT, .013[b]	5	1.38	7	1.51	8
Railroads	--	grid/county track, -[b]	--		--		--
Total			133		187		204

Grid No. 1

Description North of I-80, along U.S. 87

Area of grid, sq mi .547

Emission density, ton/yr/sq mi	243 (1974)	342 (1980)	373 (1985)

[a] GF = growth factor

[b] multiply by county emissions

Table D.1 (continued). ROCK SPRINGS EMISSION INVENTORY AND EMISSION DENSITY

Source category	Emission factor	Parameters	Particulate emissions, ton/yr 1974	GF[a]	1980	GF	1985
Fugitive dust							
Unpaved roads							
County roads	5.8000 #/VMT	12 VMT/day; 248 day/yr	9	1.25	11	1.37	12
City streets	5.8000 #/VMT		--		--		--
Local streets	1.9000 #/VMT	136 VMT/day; 248 day/yr	32	1.25	40	1.37	44
Alleys	1.9000 #/VMT		--		--		--
Paved roads							
Winter sanding	0.1700 #/VMT	8635 VMT/day; 20 day/yr	15	1.25	19	1.37	21
Cleaned roads	0.0038 #/VMT		--		--		--
Uncleaned roads	0.0600 #/VMT	10362 VMT/day; 228 day/yr	71	1.25	89	1.37	97
Unpaved shoulders	1.9000 #/VMT	36 VMT/day; 248 day/yr	8	1.25	10	1.37	11
Construction	1.06 ton/ac/mo		--		--		--
Other							
Fuel combustion	--	grid/county pop, .03[b]	3	1.50	5	1.60	5
Highway vehicles	--	grid/county VMT, .009[b]	3	1.25	4	1.37	4
Railroads	--	grid/county track, -[b]	--		--		--
Total			141		178		194

Grid No. 2

Description South of I-80, along U.S. 87

Area of grid, sq mi .319

Emission density, ton/yr/sq mi 442 (1974) 558 (1980) 608 (1985)

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[a] GF = growth factor

[b] multiply by county emissions

Table D.1 (continued). ROCK SPRINGS EMISSION INVENTORY AND EMISSION DENSITY

Source category	Emission factor	Parameters	Particulate emissions, ton/yr 1974	GF[a]	1980	GF	1985
Fugitive dust							
Unpaved roads							
County roads	5.8000 #/VMT	71 VMT/day; 248 day/yr	51	1.01	52	.99	50
City streets	5.8000 #/VMT	200 VMT/day; 248 day/yr	143	1.01	144	.99	142
Local streets	1.9000 #/VMT	140 VMT/day; 248 day/yr	33	1.01	33	.99	33
Alleys	1.9000 #/VMT	14 VMT/day; 248 day/yr	3	1.01	3	.99	3
Paved roads							
Winter sanding	0.1700 #/VMT	50266 VMT/day; 20 day/yr	85	1.01	86	.99	84
Cleaned roads	0.0038 #/VMT		--		--		--
Uncleaned roads	0.0600 #/VMT	60319 VMT/day; 228 day/yr	413	1.01	417	.99	412
Unpaved shoulders	1.9000 #/VMT	42 VMT/day; 248 day/yr	10	1.01	10	.99	10
Construction	1.06 ton/ac/mo	20 acres; 6 months	127	1.00	128	1.00	126
Other							
Fuel combustion	--	grid/county pop, .38[b]	41	1.00	41	1.00	41
Highway vehicles	--	grid/county VMT, .055[b]	20	1.01	20	.99	20
Railroads	--	grid/county track, .005[b]	1	1.00	1	1.00	1
Total			927		935		922

Grid No. 3

Description Center of town

Area of grid, sq mi 1.27

Emission density, ton/yr/sq mi 730 (1974) 736 (1980) 726 (1985)

[a] GF = growth factor

[b] multiply by county emissions

Table D.1 (continued). ROCK SPRINGS EMISSION INVENTORY AND EMISSION DENSITY

Source category	Emission factor	Parameters	Particulate emissions, ton/yr 1974	GF[a]	1980	GF	1985
Fugitive dust							
Unpaved roads							
County roads	5.8000 #/VMT	41 VMT/day; 248 day/yr	29	1.41	41	1.50	44
City streets	5.8000 #/VMT		--		--		--
Local streets	1.9000 #/VMT		--		--		--
Alleys	1.9000 #/VMT	5 VMT/day; 248 day/yr	1	1.41	1	1.50	2
Paved roads							
Winter sanding	0.1700 #/VMT	9642 VMT/day; 20 day/yr	16	1.41	23	1.50	24
Cleaned roads	0.0038 #/VMT	11570 VMT/day; 228 day/yr	5	1.41	7	1.50	8
Uncleaned roads	0.0600 #/VMT		--		--		--
Unpaved shoulders	1.9000 #/VMT		--		--		--
Construction	1.06 ton/ac/mo	12 acres; 4 months	50	1.50	75	1.60	80
Other							
Fuel combustion	--	grid/county pop, .06[b]	6	1.50	9	1.60	10
Highway vehicles	--	grid/county VMT, .01[b]	4	1.41	6	1.50	6
Railroads	--	grid/county track, -[b]	--		--		--
Total			111		162		173

Grid No. 4

Description South of S.H. 430 and north of Belt Route

Area of grid, sq mi 1.01

Emission density, ton/yr/sq mi 110 (1974) 160 (1980) 171 (1985)

[a] GF = growth factor

[b] multiply by county emissions

Table D.1 (continued). ROCK SPRINGS EMISSION INVENTORY AND EMISSION DENSITY

Source category	Emission factor	Parameters	Particulate emissions, ton/yr				
			1974	GF[a]	1980	GF	1985
Fugitive dust							
Unpaved roads							
County roads	5.8000 #/VMT	49 VMT/day; 248 day/yr	35	1.96	67	2.09	73
City streets	5.8000 #/VMT		--		--		--
Local streets	1.9000 #/VMT	85 VMT/day; 248 day/yr	20	1.96	39	2.09	42
Alleys	1.9000 #/VMT	17 VMT/day; 248 day/yr	4	1.96	8	2.09	8
Paved roads							
Winter sanding	0.1700 #/VMT	5704 VMT/day; 20 day/yr	10	1.96	20	2.09	21
Cleaned roads	0.0038 #/VMT	6845 VMT/day; 228 day/yr	3	1.96	6	2.09	6
Uncleaned roads	0.0600 #/VMT		--		--		--
Unpaved shoulders	1.9000 #/VMT		--		--		--
Construction	1.06 ton/ac/mo		--		--		--
Other							
Fuel combustion	--	grid/county pop, .06[b]	6	1.50	9	1.60	10
Highway vehicles	--	grid/county VMT, .006[b]	2	1.96	4	2.09	4
Railroads	--	grid/county track, -[b]	--		--		--
Total			80		153		164

Grid No. 5

Description North of S.H. 430 and south of U.S. 30

Area of grid, sq mi .747

Emission density, ton/yr/sq mi 107 (1974) 205 (1980) 220 (1985)

[a] GF = growth factor

[b] multiply by county emissions

Table D.1 (continued). ROCK SPRINGS EMISSION INVENTORY AND EMISSION DENSITY

Source category	Emission factor	Parameters	Particulate emissions, ton/yr 1974	GF[a]	1980	GF	1985
Fugitive dust							
Unpaved roads							
County roads	5.8000 #/VMT	17 VMT/day; 248 day/yr	12	1.58	19	1.76	21
City streets	5.8000 #/VMT		--		--		--
Local streets	1.9000 #/VMT		--		--		--
Alleys	1.9000 #/VMT		--		--		--
Paved roads							
Winter sanding	0.1700 #/VMT	9037 VMT/day; 20 day/yr	15	1.58	24	1.76	26
Cleaned roads	0.0038 #/VMT	6947 VMT/day; 228 day/yr	3	1.58	5	1.76	5
Uncleaned roads	0.0600 #/VMT	3897 VMT/day; 228 day/yr	27	1.58	43	1.76	48
Unpaved shoulders	1.9000 #/VMT		--		--		--
Construction	1.06 ton/ac/mo	30 acres; 4 months	127	0.50	64	0.50	64
Other							
Fuel combustion	--	grid/county pop, -[b]	--	-	2	1.00	2
Highway vehicles	--	grid/county VMT, .009[b]	3	1.58	5	1.76	5
Railroads	--	grid/county track, -[b]	--		--		--
Total			187		162		171

Grid No. 6

Description I-80 and U.S. 30

Area of grid, sq mi .447

Emission density, ton/yr/sq mi 418 (1974) 362 (1980) 383 (1985)

[a] GF = growth factor

[b] multiply by county emissions

Table D.1 (continued). ROCK SPRINGS EMISSION INVENTORY AND EMISSION DENSITY

Source category	Emission factor	Parameters	Particulate emissions, ton/yr 1974	GF[a]	1980	GF	1985
Fugitive dust							
Unpaved roads							
County roads	5.8000 #/VMT	227 VMT/day; 248 day/yr	163	1.19	194	1.32	215
City streets	5.8000 #/VMT		--		--		--
Local streets	1.9000 #/VMT		--		--		--
Alleys	1.9000 #/VMT		--		--		--
Paved roads							
Winter sanding	0.1700 #/VMT	18528 VMT/day; 20 day/yr	31	2.06	64	2.17	67
Cleaned roads	0.0038 #/VMT	5821 VMT/day; 248 day/yr	3	2.06	6	2.17	7
Uncleaned roads	0.0600 #/VMT	16413 VMT/day; 228 day/yr	112	2.06	231	2.17	243
Unpaved shoulders	1.9000 #/VMT	26 VMT/day; 248 day/yr	6	2.06	12	2.17	13
Construction	1.06 ton/ac/mo	90 acres; 6 months	572	1.00	572	1.00	572
Other							
Fuel combustion	--	grid/county pop, .03[b]	3	1.50	5	1.60	5
Highway vehicles	--	grid/county VMT, .019[b]	7	2.06	14	2.17	15
Railroads	--	grid/county track, .005[b]	1	1.00	1	1.00	1
Total			898		1099		1138

Grid No. 7

Description West of town and east of I-80

Area of grid, sq mi 1.427

Emission density, ton/yr/sq mi 629 (1974) 770 (1980) 797 (1985)

[a] GF = growth factor

[b] multiply by county emissions

Table D.1 (continued). ROCK SPRINGS EMISSION INVENTORY AND EMISSION DENSITY

Source category	Emission factor	Parameters	Particulate emissions, ton/yr				
			1974	GF[a]	1980	GF	1985
Fugitive dust							
Unpaved roads							
County roads	5.8000 #/VMT		--		--		--
City streets	5.8000 #/VMT		--		--		--
Local streets	1.9000 #/VMT	200 VMT/day; 248 day/yr	--	-	47	1.41	66
Alleys	1.9000 #/VMT		--		--		--
Paved roads							
Winter sanding	0.1700 #/VMT	8599 VMT/day; 20 day/yr	15	2.09	31	2.95	44
Cleaned roads	0.0038 #/VMT	10319 VMT/day; 228 day/yr	5	2.09	10	2.95	15
Uncleaned roads	0.0600 #/VMT		--		--		--
Unpaved shoulders	1.9000 #/VMT		--		--		--
Construction	1.06 ton/ac/mo	10 acres; 6 months	64	1.50	96	1.60	102
Other							
Fuel combustion	--	grid/county pop, -[b]	--	-	3	1.00	3
Highway vehicles	--	grid/county VMT, .009[b]	3	2.09	6	2.95	9
Railroads	--	grid/county track, -[b]	--		--		--
Total			87		193		239

Grid No. 8

Description North of intersection of I-80 and U.S. 30

Area of grid, sq mi .822

Emission density, ton/yr/sq mi 106 (1974) 235 (1980) 290 (1985)

[a] GF = growth factor

[b] multiply by county emissions

Table D.1 (continued). ROCK SPRINGS EMISSION INVENTORY AND EMISSION DENSITY

Source category	Emission factor	Parameters	Particulate emissions, ton/yr 1974	GF[a]	1980	GF	1985
Fugitive dust							
Unpaved roads							
County roads	5.8000 #/VMT		--		--		--
City streets	5.8000 #/VMT		--		--		--
Local streets	1.9000 #/VMT		--		--		--
Alleys	1.9000 #/VMT		--		--		--
Paved roads							
Winter sanding	0.1700 #/VMT	3229 VMT/day; 20 day/yr	--		5	1.64	8
Cleaned roads	0.0038 #/VMT		--		--		--
Uncleaned roads	0.0600 #/VMT	3875 VMT/day; 228 day/yr	--		27	1.64	44
Unpaved shoulders	1.9000 #/VMT		--		--		--
Construction	1.06 ton/ac/mo	10 acres; 6 months	--		64	1.50	96
Other							
Fuel combustion	--	grid/county pop, -[b]	--		--		--
Highway vehicles	--	grid/county VMT, -[b]	--		--		--
Railroads	--	grid/county track, -[b]	--		--		--
Total			--		96		148

Grid No. growth area

Description Northwest of the town and east of I-80

Area of grid, sq mi .701

Emission density, ton/yr/sq mi -- (1974) 137 (1980) 211 (1985)

[a] GF = growth factor

[b] multiply by county emissions

Table D.2. GREEN RIVER EMISSION INVENTORY AND EMISSION DENSITY

Source category	Emission factor	Parameters	Particulate emissions, ton/yr				
			1974	GF[a]	1980	GF	1985
Fugitive dust							
Unpaved roads							
County roads	5.8000 #/VMT		--		--		--
City streets	5.8000 #/VMT		--		--		--
Local streets	1.9000 #/VMT	127 VMT/day; 248 day/yr	30	1.00	30	1.00	30
Alleys	1.9000 #/VMT	5 VMT/day; 248 day/yr	1	1.00	1	1.00	1
Paved roads							
Winter sanding	0.1700 #/VMT	18341 VMT/day; 20 day/yr	31	1.54	48	1.54	48
Cleaned roads	0.0038 #/VMT	11004 VMT/day; 228 day/yr	5	1.54	8	1.54	8
Uncleaned roads	0.0600 #/VMT	11004 VMT/day; 228 day/yr	75	1.54	116	1.54	116
Unpaved shoulders	1.9000 #/VMT	15 VMT/day; 248 day/yr	4	1.54	6	1.54	6
Construction	1.06 ton/ac/mo		--		--		--
Other							
Fuel combustion	--	grid/county pop, .08[b]	8	1.00	8	1.00	8
Highway vehicles	--	grid/county VMT, .020[b]	8	1.54	12	1.54	12
Railroads	--	grid/county track, .005[b]	1	1.00	1	1.00	1
Total			163		230		230

Grid No. 1

Description Center of town

Area of grid, sq mi .612

Emission density, ton/yr/sq mi 266 (1974) 376 (1980) 376 (1985)

---

[a] GF = growth factor

[b] multiply by county emissions

Table D.2 (continued). GREEN RIVER EMISSION INVENTORY AND EMISSION DENSITY

Source category	Emission factor	Parameters	Particulate emissions, ton/yr 1974	GF[a]	1980	GF	1985
Fugitive dust							
Unpaved roads							
County roads	5.8000 #/VMT		--		--		--
City streets	5.8000 #/VMT		--		--		--
Local streets	1.9000 #/VMT	45 VMT/day; 248 day/yr	11	1.00	11	1.00	11
Alleys	1.9000 #/VMT	4 VMT/day; 248 day/yr	1	1.00	1	1.00	1
Paved roads							
Winter sanding	0.1700 #/VMT	8305 VMT/day; 20 day/yr	14	1.54	21	1.54	21
Cleaned roads	0.0038 #/VMT	4983 VMT/day; 228 day/yr	2	1.54	3	1.54	3
Uncleaned roads	0.0600 #/VMT	4983 VMT/day; 228 day/yr	34	1.54	52	1.54	52
Unpaved shoulders	1.9000 #/VMT	16 VMT/day; 248 day/yr	4	1.54	6	1.54	6
Construction	1.06 ton/ac/mo		--		--		--
Other							
Fuel combustion	--	grid/county pop, .03[b]	3	1.00	3	1.00	3
Highway vehicles	--	grid/county VMT, .009[b]	3	1.54	5	1.54	5
Railroads	--	grid/county track, -[b].	--		--		--
Total			72		102		102

Grid No. 2

Description Northwest of the center of town

Area of grid, sq mi .297

Emission density, ton/yr/sq mi 242 (1974) 343 (1980) 343 (1985)

[a] GF = growth factor

[b] multiply by county emissions

Table D.2 (continued). GREEN RIVER EMISSION INVENTORY AND EMISSION DENSITY

Source category	Emission factor	Parameters	Particulate emissions, ton/yr				
			1974	GF[a]	1980	GF	1985
Fugitive dust							
Unpaved roads							
County roads	5.8000 #/VMT		--		--		--
City streets	5.8000 #/VMT		--		--		--
Local streets	1.9000 #/VMT	170 VMT/day; 248 day/yr	40	1.54	62	1.54	62
Alleys	1.9000 #/VMT	17 VMT/day; 248 day/yr	4	1.54	6	1.54	6
Paved roads							
Winter sanding	0.1700 #/VMT	5040 VMT/day; 20 day/yr	9	1.54	14	1.54	14
Cleaned roads	0.0038 #/VMT	3024 VMT/day; 228 day/yr	1	1.54	2	1.54	2
Uncleaned roads	0.0600 #/VMT	3024 VMT/day; 228 day/yr	21	1.54	32	1.54	32
Unpaved shoulders	1.9000 #/VMT		--		--		--
Construction	1.06 ton/ac/mo	27 acres; 6 months	162	1.50	243	1.60	259
Other							
Fuel combustion	--	grid/county pop, .008[b]	1	2.00	2	2.00	2
Highway vehicles	--	grid/county VMT, .005[b]	2	1.54	3	1.54	3
Railroads	--	grid/county track, -[b].	--		--		--
Total			240		364		380

Grid No. 3

Description South of the center of town along S.H. 530

Area of grid, sq mi 1.05

Emission density, ton/yr/sq mi 229 (1974) 347 (1980) 362 (1985)

---

[a] GF = growth factor

[b] multiply by county emissions

Table D.2 (continued). GREEN RIVER EMISSION INVENTORY AND EMISSION DENSITY

Source category	Emission factor	Parameters	Particulate emissions, ton/yr				
			1974	GF[a]	1980	GF	1985
Fugitive dust							
Unpaved roads							
County roads	5.8000 #/VMT		--		--		--
City streets	5.8000 #/VMT	150 VMT/day; 248 day/yr	108	1.54	166	1.54	166
Local streets	1.9000 #/VMT		--		--		--
Alleys	1.9000 #/VMT		--		--		--
Paved roads							
Winter sanding	0.1700 #/VMT	3780 VMT/day; 20 day/yr	7	1.54	11	1.54	11
Cleaned roads	0.0038 #/VMT	2268 VMT/day; 228 day/yr	1	1.54	2	1.54	2
Uncleaned roads	0.0600 #/VMT	2268 VMT/day; 228 day/yr	16	1.54	25	1.54	25
Unpaved shoulders	1.9000 #/VMT		--		--		--
Construction	1.06 ton/ac/mo		--	-	162	1.00	162
Other							
Fuel combustion	--	grid/county pop, .04[b]	4	2.00	8	2.00	8
Highway vehicles	--	grid/county VMT, .004[b]	1	1.54	2	1.54	2
Railroads	--	grid/county track, -[b].	--		--		--
Total			137		376		376

Grid No. 4

Description Southeast of the center of town--growth area

Area of grid, sq mi 1.19

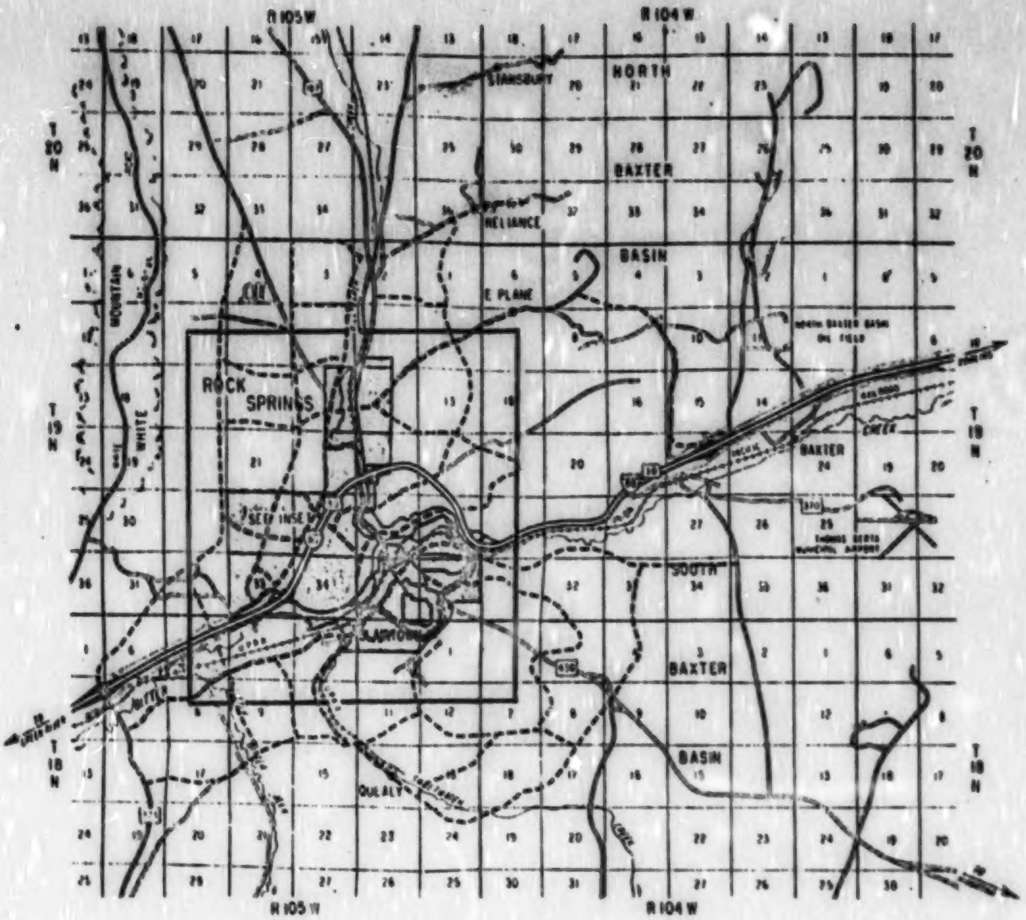
Emission density, ton/yr/sq mi 115 (1974) 316 (1980) 316 (1985)

[a] GF = growth factor

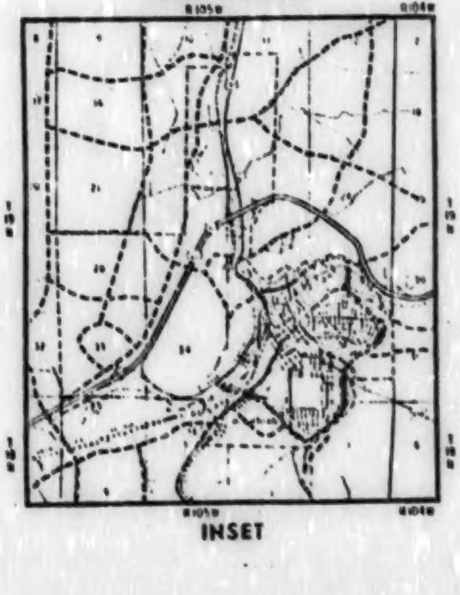
[b] multiply by county emissions

APPENDIX E

ROCK SPRINGS PROPOSED ARTERIAL STREET SYSTEM


R105W
R104W
T20N
T19N
T18N
NORTH
BAXTER
BASIN
STANSBURY
RELIANCE
E PLANE
ROCK SPRINGS
SEE INSET
NORTH BAXTER BASIN OIL FIELD
BAXTER
MUNICIPAL AIRPORT
SOUTH
BAXTER
BASIN
QUEALY
WHITE MOUNTAIN
BITTER CREEK
R105W
R104W

ROCK SPRINGS

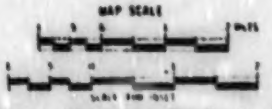

R105W
R104W
T19N
T18N
R105W
R104W

INSET

ROCK SPRINGS
PROPOSED ARTERIAL STREET SYSTEM

LEGEND

	MAP	INSET
PROPOSED ARTERIALS	╍╍╍╍╍	╍╍╍╍╍
COMMITTED ARTERIALS	━━━━━	━━━━━
EXISTING ARTERIALS	─────	─────
STREETS	NOT SHOWN	┄┄┄┄┄
LOCAL ROADS	┄┄┄┄┄	┄┄┄┄┄
URBAN BOUNDARY	━━━━━	╍╍╍╍╍


MAP SCALE
MILES
SCALE FOR INSET

source: Wyoming Highway Dept.